PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

SEPTEMBER, 1938

A. PRESCOTT FOLWELL, Editor — VOL. 69. NO. 9 — W. A. HARDENBERGH, Asso. Editor

Contents

EDITORIAL 19

HIGHWAYS AND STREETS:

Controlling Erosion Along Newly Constructed Highways 12
Safety in Sidewalk Maintenance. *By Hugh B. Rice* 17
Mapping Michigan Roads 18
Cotton Fabric and Asphalt for Road Shoulders 18
Right to Money Saved in Reletting Contract 18
Highway Ditch Checks Should Be Installed Early. *By W. A. Stacey* 22
Planning and Organization for Snow Removal and Ice Control 26

SEWERAGE AND SEWAGE TREATMENT:

A Year's Experience Operating a Chemical Precipitation Plant. *By John W. Hood* 15
The Digestion Tank 30
Liability for Sewage Overflow 37
Liability Under Sewer Construction Contract 37
The Operation of Sewage Treatment Plants 38

WATER SUPPLY AND PURIFICATION:

How Nashville Serves Suburban Customers. *By R. L. Lawrence, Jr.* ... 9
Revamping an Old Filter. *By D. Y. McDowell* 20
Water Consumption Rates in American Cities 24
Contemplated Water Works Construction 25
Creve Coeur Builds a Water System 25
The WATER WHEEL 34
Damage from Bursting Water Main 37

GENERAL:

A City's Unusual Services to Its Citizens 14

DEPARTMENTS:

Keeping Up With New Equipment 67
Readers' Service 71
The Engineer's Library 74

TIMEWASTERS

Dora, whose age was fixed last month at 18, writes in rather indignantly to say that . . . well, you know that one about figures not lying, etc. Through Mr. Wolverton from out in Wisconsin she sends mathematical proof that she is now only 11 years and 4 months old. The original problem was this: Says Dumb, "I am now 28 years old; how old are you?" Says Dora, "Four years before I was born you were twice as old as I was when you were five years younger than I am now." Well, how old is Dora? Says Mr. Wolverton: "Four years before Dora was born (11 1/3+4= 15 1/3), Dumb was (28—15 1/3=12 2/3) years old. Five years younger than Dora is now (11 1/3—5= 6 1/3), Dumb was twice as old (6 1/3x2=12 2/3)." So! What do our senior mathematicians say now?

Lots of comment, too, on the hog situation. There are, of course, many solutions. The least number of hogs to satisfy the terms of the will is 3121, with the eldest son getting 624, the next son 499, the third son 399, the fourth son 319, the fifth son 255, the nephew 5 and the daughters 255 each. Other numbers that fit (we believe) are 49,996, 99,996 and 799,996, which latter, especially, would be quite a flock of hogs—"too many for any one man," as Mr. Blunk says. Thanks, Mr. Lamoureux, for your fine analysis.

Snakes Don't Count:

Borrowed from Johns-Manville's *Power Specialist*: There are 36 heads in a menagerie, and 100 feet. How many beasts and how many birds (fish and snakes not counting) were there?

Walk, Don't Run!

Mikey is walking along the diagonal of a square field, ABCD, from B to D at the uniform rate of 5 feet per second. Ikey proceeds along the side of the field from B to C at such a rate that the positions of Ikey and Mikey at any moment lie on a straight line which, when produced, would pass through A. At what rate is Ikey moving when Mikey has walked one-fourth of the distance from B to D? *Contributed by John Bevan.*

SUBSCRIPTION RATES: United States and Possessions, Canada, Mexico and Cuba, $3.00. All other countries, $4.00. Single Copies, 35 cents each.

FOUNDED IN 1896

Published monthly by the PUBLIC WORKS JOURNAL CORPORATION, 310 E. 45th St., New York, N. Y. J. T. MORRIS, *President;* W. A. HARDENBERGH, *Vice-Pres.;* CROXTON MORRIS, *Treasurer. Advertising Manager,* ARTHUR K. AKERS, 310 East 45th St., N. Y. *Advertising representatives,* FRED R. JONES, 228 No. La Salle St., Chicago, Ill.; ALONZO HAWLEY, 1635 E. 25th St., Cleveland, Ohio.

YOU'RE THE DOCTOR

For healthy water supply and sewage systems . . . prescribe Darling Valves and Fire Hydrants!

Your choice of valves and fire hydrants can make a big difference in the health and well-being of the entire system. Choose the right valve and hydrant—and you will avoid plenty of trouble!

Darling Valves and Fire Hydrants are designed and built to do a superlative job. Darling users will tell you that Darlings *save money and worry*—every day.

Darling representatives have the experience and skill to solve your particular problems. Get in touch with our nearest representative today.

DARLING VALVE & MFG. COMPANY
WILLIAMSPORT, PA.

Representatives in:

New York, Philadelphia, Pittsburgh, Houston, Oklahoma City, Toledo, Evanston, Ill.

The large barrel of the Darling Fire Hydrant assures an abundance of water at all times. There are five other important advantages.

Darling Valves are the choice of those who insist on dependable performance.

DARLING
GATE VALVES AND FIRE HYDRANTS

The large barrel of the Darling Fire Hydrant assures ample water supply at all times.

Experience favors Darling Valves.

For sewage disposal and filtration plants, Darling Gate Valves are different in operation — more dependable in performance.

Engin.
Nelson
3-F-40

PUBLIC WORKS
City, County and State Engineering and Construction

SEPTEMBER, 1938
VOL. 69. NO. 9

How Nashville Serves Suburban Customers

By R. L. LAWRENCE, Jr.
Superintendent and Chief Engineer, Nashville Waterworks Dept.

NASHVILLE, the capital of Tennessee, is located on the Cumberland river, one of the few large navigable streams in this country. The population of Nashville, according to the 1930 census, was approximately 154,000, although the metropolitan area has a population of approximately 215,000. The Waterworks Department supplies water to 40,000 customers, 34,000 of whom are located within the corporate limits and approximately 6,000 without the city.

The Cumberland river, with a watershed above the city of 12,500 square miles, furnished a practically inexhaustible source of supply; and the watershed is comparatively sparsely settled, there being no large sources of pollution above Nashville.

The Department possesses a very modern filtration plant of the rapid sand type with a capacity of 42 m.g.d. Clarification and purification are accomplished by aeration, coagulation with subsequent settling and filtration; and chlorine and ammonia are employed as sterilization agents.

The pumping equipment also is very modern and efficient, the capacity of the pumping plant being 40 m.g.d., in duplicate.

An average of 20 million gallons a day of pure and sparkling water is prepared at these plants and is distributed through 464 miles of mains, of which 358 miles are located within the corporate limits and 106 miles of privately-owned mains are without the city.

This Department also installs and maintains, at its own expense, 2500 fire hydrants, thereby saving, in fire hydrant rentals, thousands of dollars annually by municipal ownership; which ownership dates back to 1834, over 104 years ago.

The rates in force within the corporate limits allow 1,000 cubic feet per quarter for $1.50 as a minimum. The rates to consumers outside of the city are double those within the city, with the exception of educational institutions and manufacturing plants using steam.

Regulations for Service Outside City Limits

As stated, about fifteen per cent of the water furnished by the Department goes to individuals or corporations outside the city limits, through mains laid by themselves, but only when this private distribution system is laid in compliance with the regulations of the Department. The essential features of these regulations, free from the (presumably) necessary legal verbiage are given below.

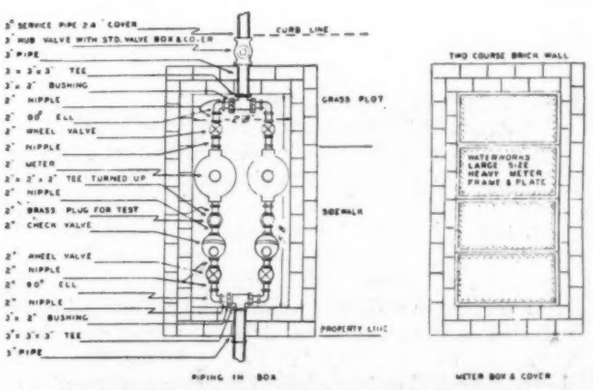
The routes, sizes and locations of mains, shown on a plan of the subdivision, must first be approved by the Superintendent and Chief Engineer of the Waterworks Dept. With this as a basis, permission must be obtained from the Board of Public Works to connect the proposed pipes with the city mains, under the regulations of the Water Dept. Also all necessary permits from city, county or state for street excavation.

The mains must be laid by a plumber licensed by the City of Nashville under a $2,000 bond, under the supervision of the Department engineers; a Department inspector being paid $5 a day for inspecting and checking the materials used and the installation of all mains of 3″ size or larger, none of which shall be laid except in his presence. The plumber must employ only competent and efficient laborers and first class mechanics satisfactory to the Department.

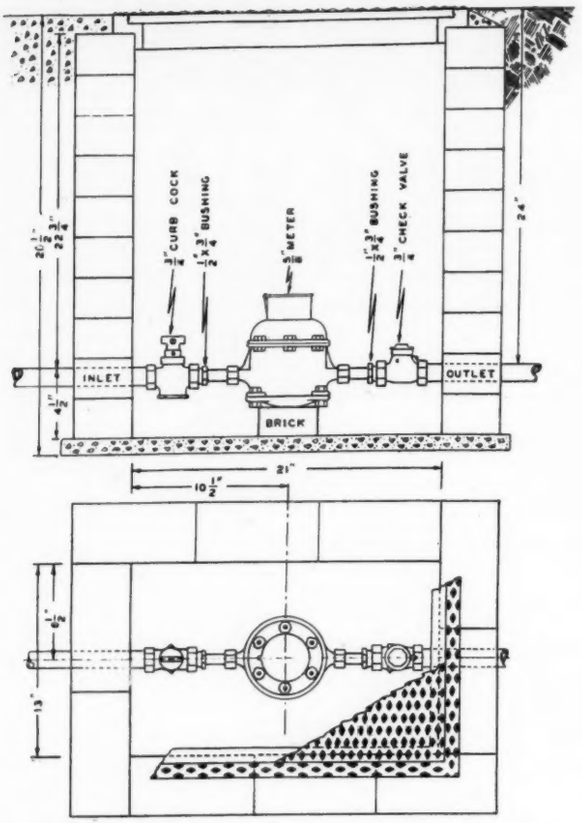
Materials

Pipe must be Class 150 centrifugal or equivalent, bell and spigot cast iron, laying between 12 and 16½ ft. (18 ft. may be permitted by the Supt. of the Dept.); with certificates of inspection, covering every length, sworn to and stating that all pipe were made and tested in accordance with Federal Specifications W.W.P.-421 dated July 21, 1931, and have withstood 500 lb. hydrostatic pressure.

Valves larger than 2″ are iron body, double gate, bronze mounted, hub ends, tested to 300 lb. pressure, conforming in every respect to the AWWA specifications as a minimum, opening to the right with a 2″ square nut on top of stem, and made by either Ludlow or Rensselaer. Tapping sleeves and valves must be



2-inch battery meter installation on a 3-inch service



Regulation meter box and setting for ⅝ inch meter

A. P. Smith or Rensselaer and suitable for use with an A. P. Smith tapping machine. The 2″ valves may be Ludlow, Rensselaer, Crane or an approved equal; with screw ends and wheel valves, but otherwise similar to the larger ones.

Valve boxes are made up of pre-cast 1:2:4 concrete sections 11″ x 13½″ inside and 17″ x 19¼″ outside, and 12″ to 15″ high for 8″ and 12″ valves and 15″ to 18″ high for smaller valves; reinforced with ¼″ steel rods placed horizontally 1½″ from the face of the concrete and spaced about 3″ apart vertically, and vertical rods in each corner of the box and the middle of each side. The frames and covers shall weigh at least 150 and 45 lb. each, respectively, of the dimensions shown on the drawing, made of strong, tough pig iron containing not more than 50% heavy machine scrap, made in closed flasks, the cover to fit on the frame without rocking.

Laying Mains

The property lines of the roads must be staked out and the mains laid at a constant distance from such lines, and at such depth that the tops of the hubs will be 30″ below the finished grade of the street. (Either line or grade may be changed by the Dept. engineers if necessary to pass obstructions, but under no condition shall the cover be less than 24″.)

When connections are made under pressure, the Dept. will furnish tapping machine and operators, charging $3.00 tapping fee. Lead used in making joints shall be 2″ deep for 3″ to 6″ pipe and 2½″ deep for larger pipe, the weight used per joint being approximately that specified in a table (6.00 lb. for 3″ to 77.25 lb. for 36″). The specifications for yarning, pouring and calking are those in ordinary practice, no calkers being employed whose work is not satisfactory to engineers and inspectors of both Dept. and city. In the case of deflected pipe 16″ or larger, the inspector may require the joints to be run solid and calked both inside and outside; also the use of short lengths of pipe on curves to minimize joint deflection.

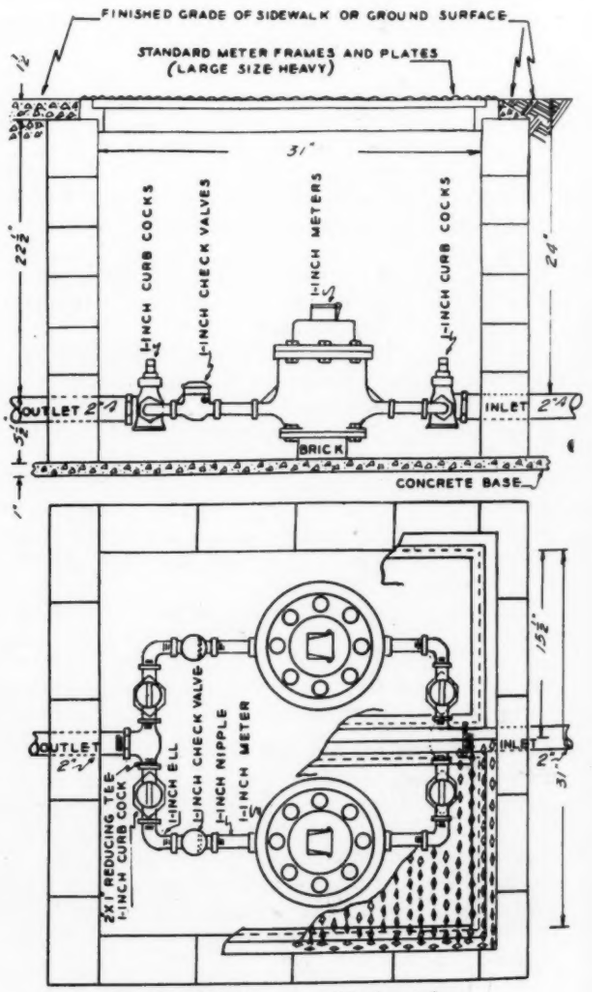
Pipe larger than 12″ must, before the joints are poured, be properly aligned, using wooden blocks and wedges 3″ x 3″ or 4″ x 4″ by 12″ long, placed firmly at right angles to the pipe.

In backfilling the trench, the pipe must be given a uniform bearing, thoroughly tamping material that contains no large stones under and around the pipe; and replacing and tamping the remaining material in 6″ layers, using no large stone at a less distance above the pipe than 12″; although the engineer may permit water tamping after 6″ covering is on the pipe. If rock is encountered, it must be removed about 6″ below the pipe and replaced with earth or 2″ crushed stone; and the same material used in backfilling up to approximately 12″ above the top of the pipe.

Where a pipe line crosses under railroad tracks, extra depth may be required, or installing a larger pipe as a sheath to protect the main. In no case will depth from bottom of cross ties to top of hub of pipe be less than 30″. Pipe shall be so laid that no joint comes under or between the rails of any single track.

Testing and Sterilizing Mains

Pipe lines must be tested before being covered, by filling a section between valves with water from the city mains, closing the valves, and pumping into the section until 125 lb. is attained and maintaining this for 10 min., joints and line being meantime examined by the inspector for defective castings, excessive leakage or weakness. A leakage test also is required. (See article



Two 1-inch meters on a 2-inch service

to appear in the next issue "Leakage Tests of Newly Laid Water Mains.")

The plumber must supply the pumps and all other equipment for making tests except the meter for recording the leakage and the recording pressure gauge. The inspector or engineer may require the pipe line to be left uncovered until he is satisfied that it is water tight.

As each length of pipe is laid, the plumber must clean the inside of all dirt or debris, and place in it powdered HTH or Perchloron (of not less than 65% available chlorine), using 1/9 oz. for 3″ pipe, 1/6 oz. for 4″, ½ oz. for 8″, to 3 oz. for 24″, based on 12 ft. lengths of pipe. Or he may be required to introduce the desinfectants in solution under the instructions of the engineer. When the line is tested for strength and leakage it is filled slowly and kept standing full for at least 12 hrs. to give the chlorine time to act; then thoroughly flushed until the chlorine residual is reduced to that customary in treating water for consumption. Following this, the city may have samples of water from the tested section analyzed for bacteriological condition as well as chlorine, and hold the line out of service and require the plumber to continue sterilization of it until the city is sure it is free from contamination and safe in every way.

Services

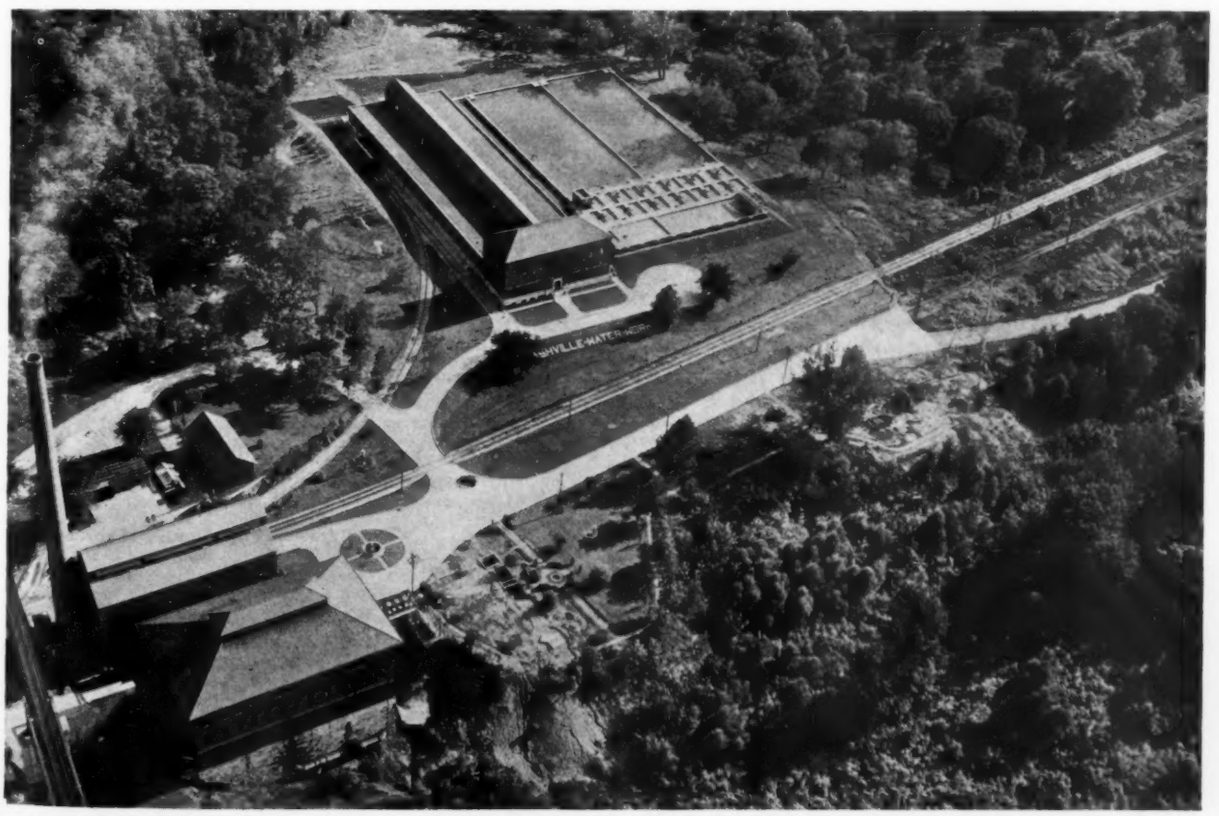
Service pipes are laid by licensed plumbers at least 2 ft. below surface of street or private property, at least 3 ft. from any sewer service; every part of the service either parallel to or at right angles to the curb line. The tap and service from main to meter must be at least ¾ in. Services 1″ and under from a c. i. main are full lead; those from galvanized iron mains may be lead or galvanized iron, but if the latter there must be 18″ of flexible lead pipe between the main and iron service. Services larger than 1″ and less than 3″ are genuine wrought iron pipe. Services 3″ and larger are of cast iron not less than Class B. Lead pipe has 1.5″ outside diameter for 1″ pipe, 1.22″ for ¾″ pipe. To prevent tension in lead service between main and meter, the corporation goose neck is turned parallel to the main and the lead service brought back parallel to it to a point in line with the tap, thence straight to the meter; the service pipe being made 12″ longer than the distance from main to meter to permit this.

Meter boxes are built of whole brick with concrete bottom, of dimensions specified by the Dept. and 2 ft. deep, with a plate and frame cemented on the top, level with the ground or sidewalk. A brick is placed crosswise on the bottom for the meter to rest on. A curb cock is attached, with the necessary bushing, directly to the front of the meter. No meter larger than 2″ is used. Where this is not large enough, batteries of meters are connected in, with a gate valve on each side of each meter in the meter box. The Superintendent may require a battery of 1″ meters on a 2″ service. The consumer must furnish all meters larger than ⅝″, also those for upstairs apartments, and all sizes outside of city limits.

The procedure for installing a service line is:

1—Build meter box
2—Install service pipe between meter box and a point within house foundation
3—Install service pipe from meter box to main
4—Make tap and connections to main
5—Turn on water, flushing out service from main to meter box
6—Set and connect up meter.

The Dept. is not responsible for damage to consumer's equipment due to high pressure; he is supposed to install a pressure regulator between the main and the inside of his premises; also a check valve in his service line if it is connected to a hot water tank or steam boiler.



Nashville waterworks plant, viewed from plane above the river. Power and pumping station at the left. Filtration plant in the center. River bank in foreground.

Controlling Erosion Along Newly Constructed Roads

"NO SOONER is a new road constructed," says the Department of Agriculture in Bulletin 380, "than the forces of nature are at work to destroy it. Water and wind, cold and heat, and the constant pull of gravity combine to break up the road surface, tear down the fills, and round off the squared edges of shoulder berms and back-slopes. . . . On newly improved roads, the wear by traffic is unimportant compared with the work of these natural forces, and of these forces, the most powerful by far is water."

As in most matters, prevention is preferable to cure. Much can be done in planning and constructing new roads to prevent erosion. On roads already built, corrective measures are necessary.

Preventive Measures

MODERN standards of highway construction as regards alinement, width and grade are the primary causes that contribute to the problem, because these features result in a large volume of excavation and numerous cuts and fills. In forest and mountain highways, which are largely recreational in nature, strictly commercial criteria of minimum grades and curvature should not be permitted to dictate location. In fact, the most effective way to minimize erosion is to fit road alinement to topography. Not only does this reduce the volume of earth and rock that is loosened and rendered unstable, but also accomplishes the desirable purpose of safeguarding scenic values.

Retaining Walls and Cribbing—A more liberal use of walls of native rock and of metal or concrete cribbing will reduce the volume of both cuts and fills by restraining slides on the upper side of the road or to support shoulders or the toes of slopes on the lower side.

On slopes that are too steep to hold overcast material, it is common practice to cut into the hill a section sufficient to carry the entire width of the road. This requires a great deal of excavation. If this is overcast, it leaves a bad scar and may cause additional damage by washing or sliding below; if end-hauled, it increases the cost. In such cases, the proper use of cribbing to support up to one-third of the road width, would limit the overcast material to the small amount necessary for the crib excavation, as the crib will carry all or nearly all of the material excavated for the reduced bench width, as shown in the illustration.

Controlled Placement of Material—Excess material, unavoidably excavated during construction or brought down by unpredictable slides often causes damage. After completion, the sloughing and washing of the slopes of cuts is the chief source of such material. It is, of course, impossible to "anchor" all of this, but much can be placed in the basins formed upstream by through fills. By means of drop inlet culverts, with the opening covered with a trash rack, water can be drawn off while the basin is filled with detritus and slide material that otherwise would offer a problem in disposal.

Where slopes are easy (less than 1½ to 1) the areas below inside curves of the road can be filled to provide, ultimately, parking or picnic areas. Toe walls or cribbing may be needs to retain the slopes; and a drain or culvert must be carried through. Hauling of the excess material to these areas is the greatest element of cost.

Where walls or cribs cannot be provided, but where overcasting must be avoided, the excess material can be hauled to an area of gentle slope, well covered with vegetation and spread as a shallow fill; or dumped at a few carefully selected waste stations, preferably natural rock slides on slopes terminating in flats on which the talus can be held and overgrown.

Tunnels and Bridges—The use of occasional tunnels, where rock structure permits, in place of long deep cuts, and of bridges in place of heavy fills is desirable. The deeper the cut, the greater the displacement of earth and the more likely there will be slides and erosion. Even where the rock is fractured and soft, necessitating concrete lining, tunnels may be desirable because it is in exactly such places that the greatest trouble from slides occurs, both during and after construction.

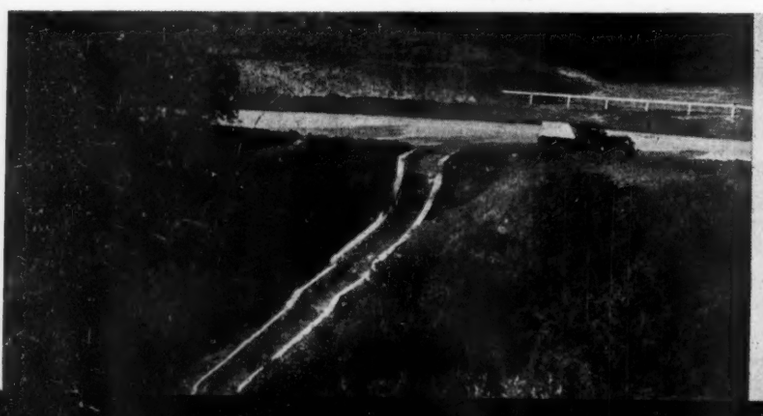
Improved Drainage—Adequate drainage is really the first step in erosion control. Inasmuch as it applies even more fully to existing roads, it will be discussed under that heading.

Control Measures for Existing Roads

THE corrective or countererosion activities fall into two broad divisions—improved and effective drainage and slope stabilization by vegetation. Proper drainage is a prerequisite to slope stabilization.

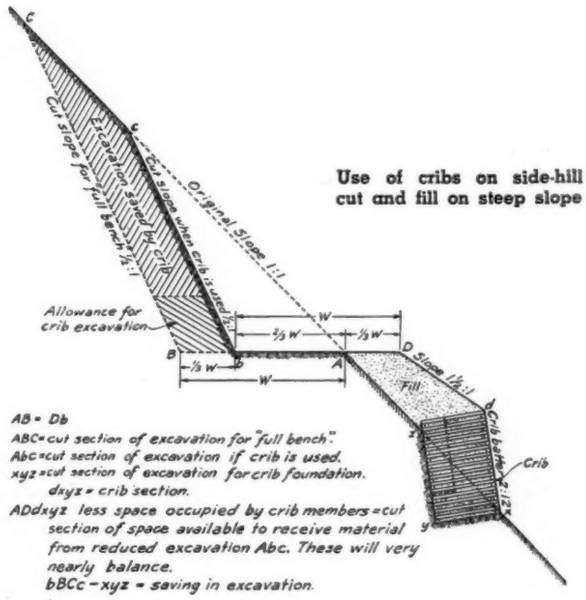
Drainage Measures—A most destructive practice is the emptying of pipe culverts on the middle or down one edge of highly erosible fill slopes, with resultant cutting out of gullies, or side cutting of slopes. Emp-

Flume for removing culvert discharge



Slope protected by planting of shrubs

tying culverts upon adjacent brush-covered slopes is almost equally destructive. Where the final channel cannot be reached directly, the drainage structure should be extended to solid rock ledges from which the water can reach natural channels over rock; or the water should be carried in a pipe or flume down the slopes to empty upon rock talus where this is firm enough to resist erosion. Metal culverts or half-culverts or masonry flames are suitable.


Cut slope for full bench 1½:1
Excavation shown for crib
Cut slope when crib is used 1:1
Original Slope 1:1
Allowance for crib excavation
W
⅔ W
⅓ W
⅓ W
W
D Slope 1½:1
Fill
Crib batter 1:12
Crib
AB = Db
ABC = cut section of excavation for "full bench".
Abc = cut section of excavation if crib is used.
xyz = cut section of excavation for crib foundation.
dxyz = crib section.
ADdxyz less space occupied by crib members = cut section of space available to receive material from reduced excavation Abc. These will very nearly balance.
bBCc − xyz = saving in excavation.

Use of cribs on side-hill cut and fill on steep slope

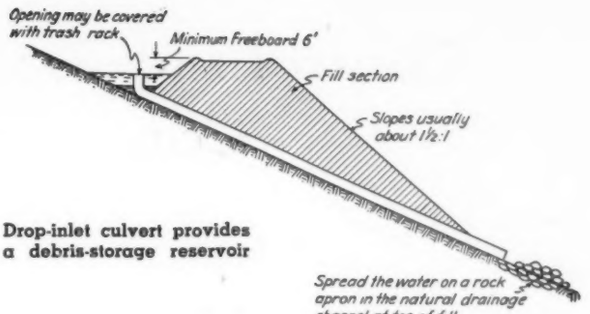
Where culverts must, of necessity, discharge upon erosible material, adequate outfall aprons of heavy riprap, or basins of masonry, concrete or even logs may be built to prevent damage.

When drainage outlets are too few or not properly placed, ditches erode, shoulder berms are side cut or destroyed and water may pass over the road. Lack of drainage is especially serious at low points of inside curves on fills, as a pool forms behind the shoulder berm at the low point and finally pours over, cutting a notch in the berm and a gully in the fill slope. Such conditions are corrected by providing more numerous outlets for taking water from the road, since the smaller the volume of water, the less its erosive power. The best way to locate the points that need attention is to inspect the road after a heavy rain.

Small culverts cause damage by backing up flows from heavy storms; culverts as small as 12 inches in diameter often are clogged by debris. It is better to use culverts with a minimum diameter of 16 to 18 ins.

On some roads built by the CCC in the western mountain areas, the entire road is given a slight pitch toward the outer shoulder to permit continuous runoff laterally. The economy sought by this method is not always (or even usually) attained, as the saving in drainage structures is more than overcome by the resulting erosion. Shoulders settle and wear rapidly during heavy rains; despite all efforts to build and maintain uniform outward slopes, water accumulates and runs down the axis of the road to an obstruction or depression, where it pours out with sufficient volume and force to cut a gulley. In a short time the outer wheel track is corrugated, often to the point where it is dangerous.

When new roads are built, stretches of abandoned roads are sometimes left. These may damage the new roads by depositing eroded material on them. If the

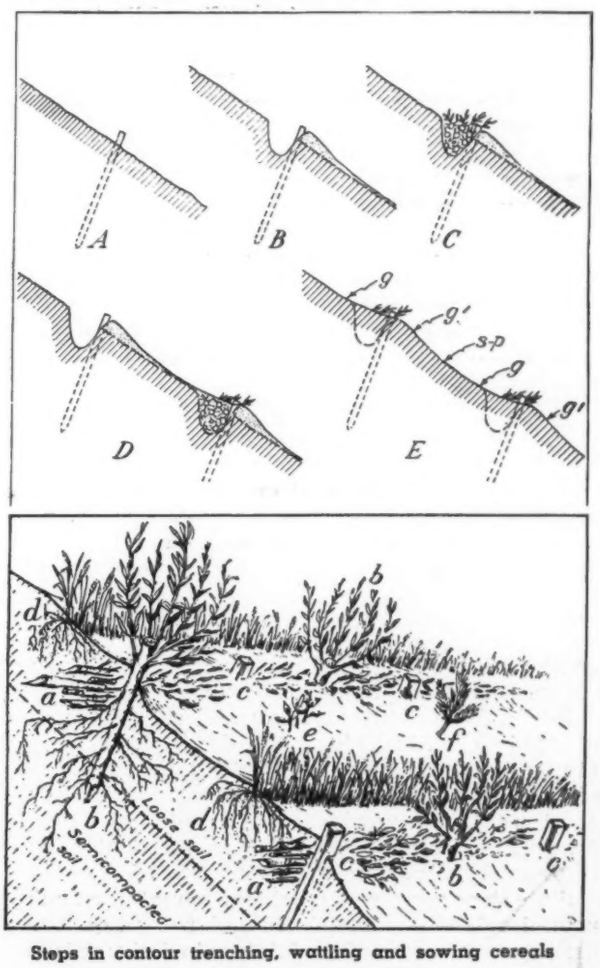

Opening may be covered with trash rack
Minimum Freeboard 6"
Fill section
Slopes usually about 1½:1
Spread the water on a rock apron in the natural drainage channel at toe of fill

Drop-inlet culvert provides a debris-storage reservoir

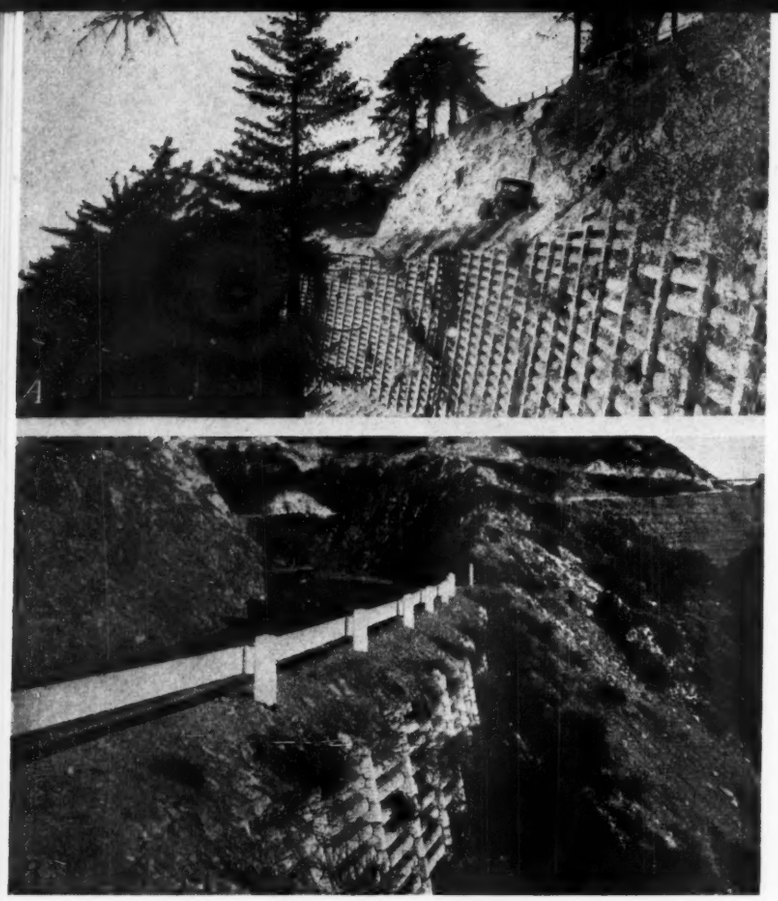
old road is to be continued in use as an emergency way, it should be properly drained; if not, it should be made completely erosion proof, or plowed or scarified and seeded with native trees and shrubs.

Treatment of Fill Slopes

IF THE road is properly drained, the fill slopes will require protection only against wind, gravity and the rain that falls directly on them. Stated most simply, this protection comprises four steps: (1) Preparing the slope by smoothing existing gullies and combing down loose rock; (2) mechanical anchorage of the slope surface by a system of contour trenching, imbedded wattling and staking in such combinations and spacings as are best suited to local soil conditions; (3) the sowing of cereal grains or other quick-growing annuals to gain the rapid soil binding benefits of the fibrous roots of this temporary vegetation; and (4) the planting of suitable trees and shrubs to establish a complete self-perpetuating cover of vegetation on the slope and thus make soil control permanent.



Steps in contour trenching, wattling and sowing cereals



Top—Interlocking cribbing protects trees on slope below. Bottom—Small crib reduces the cut necessary

The smoothing of the slopes will be done by suitable equipment or with hand tools depending on the size of the job and conditions of work. On badly eroded slopes, it will not be possible to eliminate the large and deep gullies, but these should be rounded off to as flat a curvature as possible.

The steps in anchoring the soil by contour trenching, imbedded wattling, staking and sowing of cereal grains are shown essentially in the accompanying illustrations, and the process is described in detail in Circular 380, Department of Agriculture, Erosion Control on Mountain Roads, by Charles J. Kraebel, Senior Silviculturist of the Forest Service. This circular, from which the data contained in this article were abstracted, can be purchased from the Superintendent of Documents for 10 cents.

The soil in fill slopes, although largely subsoil and therefore supposedly sterile, is usually found to produce excellent growth because of the thorough mixing and aeration to which it is subjected in the road-building process.

Maintenance and Repair

CONSTANT inspection and maintenance of erosion control work is especially important during the first rainy season after completion. Provision for this first-season maintenance should be made at the time the erosion control program is set up.

Intelligent maintenance starts with a knowledge of what to look for. Breakdowns are of two general types: (1) Gullies and side-cutting resulting from spillovers of road surface water at points where sufficient drainage has not been provided or where drainage structures have become clogged; (2) failure of the slope treatment by sloughing or slumps.

Since slope treatment is designed to control only the natural rainfall on the slopes and not concentrated drainage water, correction of defects in drainage is the first step. Gullies should be repaired by scarifying transversely or trenching the bottoms, filling, compacting, heavily staking and rewattling. Stakes should reach into the compact original bottom; and even double staking may be desirable. The bond between the gully bottom and the new fill material should be made as good as possible.

Slumps are most liable to occur on slopes containing a large proportion of clay. Repairs should follow essentially the same general practice as in gully repairs, but even greater care should be taken to establish the bond between the slump-exposed surface and the new fill. Trenches should be deeper or closer together and stakes larger and longer. Long stakes driven into the slope just above the slump aid in preventing further sloughing.

In no place is timely inspection and attention more important than in repair and erosion-proofing of culvert outfalls. The downhill location of such outlets makes them hard to see and necessitates climbing down the slopes to inspect them at close range.

A City's Unusual Services to Its Citizens

Outremont, Quebec, a community of 30,000 and a suburb of Montreal, performs a number of unusual services which citizens of other cities usually do themselves or hire done. This city, for example, contracts for private improvements such as laying concrete walks, building rock gardens, selling and planting shrubs, trees, and flowers, constructing driveways and many other improvements at cost, plus 15 per cent of labor charges to cover administration. Most of this work for private individuals is done at times when there is a lag in the regular municipal public work activities.

The city also owns a boulevarding strip varying from 5 to 23 feet back from the sidewalk towards the private residences and, consequently, is responsible for keeping the grass cut. For a service fee the city will contract to cut grass to the householder's door or even to the end of the lot. The city will cut the grass on private property for a service charge of $2.00 for the first 250 square feet and $1.50 for each additional 250 feet. The grass cutting service is rendered at least once a week from May 1 to October 1; grass cutters have before them a schedule of householders taking the full lawn cutting service. The grass in the boulevarding strips is watered throughout the hottest days of summer with watering trucks equipped with an attachment, invented by the city manager, which will spray the water effectively for 50 feet. So far as can be ascertained, Outremont is the only city rendering these two services.

The city has appointed an "Embellishment Committee" which, through the medium of newspapers, schools, and contests, has obtained great success in promoting a more beautiful city. Over 200 gardens and plots were examined last year in determining the distribution of eight cups and trophies.

The streets are bare of poles except those for ornamental lighting, all utility services being underground or, in some cases, through the alleys.

The city finds it worthwhile to maintain a large greenhouse and nursery. These activities, together with the public maintenance of most of the city's front lawns, make the city uniformly well kept and beautiful. R. E. Lacroix, who has been city manager of Outremont since 1924 is also city engineer.—By EDWARD W. HARDING in *Public Administration Service.*

John W. Hood

A Year's Experience with Chemical Precipitation

By JOHN W. HOOD
Plant Engineer

R. A. Hartom, City Engineer

THE Ridgewood, N. J. Sewage treatment plant was completed early in 1937, and, following plant scale tests in which various types of coagulants were tried, actual plant operation using aluminum sulphate (the standard filter alum of water purification practice) as the coagulant was begun July 1, 1937. The plant is under the supervision of R. A. Hartom, village engineer, who was in general charge of design and construction. E. T. White is commissioner of public works.

The Ridgewood plant consists of a Link-Belt Tritor screen (with bars removed) which functions as a grit removal apparatus; Chicago comminutor which eliminates the worries of screenings disposal; preliminary sedimentation tank, which formed a part of the original plant; flocculator; second settling tank; low lift pumping station; trickling filters, also a part of the original plant; secondary settling tank to treat the effluent from the trickling filters; primary heated sludge digester with stirring mechanism and gas collection equipment; secondary digester, without heat, gas collection or mechanical equipment; and covered sludge drying beds. The flocculator and all clarifier mechanism is Dorr; the digester mechanism was furnished by Hardinge; the pumping equipment by Fairbanks-Morse; and the sludge bed covers by Lord and Burnham.

The plant was designed for an average flow of 1 mgd.; at present the daily peak is about 1,400,000 gpd. Since the clarifiers are run in series the detention in them is short; during the hours of maximum flow coagulated sewage is held less than one hour in clarifier No. 2. Design bases were normal throughout the plant for the estimated volume of sewage.

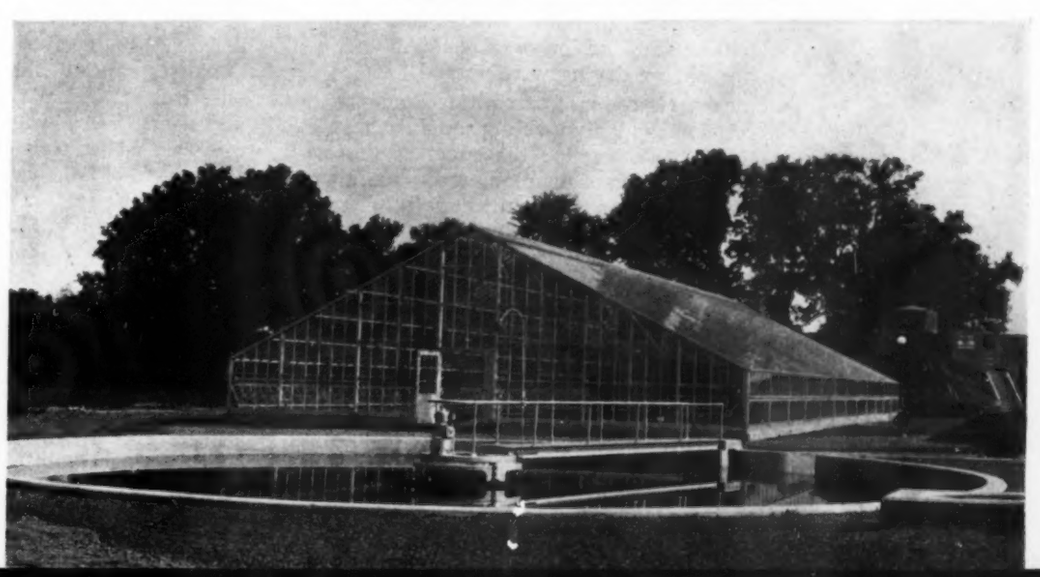
Applying aluminum to the primary clarifier effluent (that is, to settled sewage), a dosage of 70 to 80 ppm., or around 4 or 5 grains per gallon, is sufficient ordinarily to produce a crystal clear effluent from clarifier No. 2. This effluent, when placed in an Imhoff cone, can not be distinguished from tap water. B.O.D. (5-day) of raw sewage is 250 to 350 ppm.; of coagulated and settled effluent 28 to 45 ppm.; and trickling filter effluent 12 to 35 ppm. In raw sewage D.O. is absent; in trickling filter effluent it averages 5.5 ppm.

As operation got under way, it was found difficult to maintain a clear effluent during the period from 8 A. M. to 2 P. M., especially on Mondays. Increasing the dose of chemical did not materially improve the quality of the effluent. Laboratory tests using both iron and aluminum salts were conducted simultaneously with the plant experiences and served only to confirm the observation of the plant results.

Various aids to chemical precipitation which had been successfully used in water practice—by pre-acidulation with sulphuric acid; pre-treatment with sodium silicate, plain and activated with sulphuric acid; pre-treatment with hydrated lime; and pre-aeration and chlorination—were tried both on plant and laboratory scale. The cooperation of M. F. Koblish of the General Chemical Company who participated in this work and furnished chemicals and reagents is gratefully acknowleged.

To establish the character of sewage while yet in the collection system, a series of samples taken from various locations on November 17, 1937 was tested for coagulant demand. Up to 300 ppm. were employed without effecting clarification or forming good settleable floc on even the freshest sewage. Evidently it was not a question of putrefaction in the sewers en route to the plant. The coagulation problem was present in the sewage, in laterals and possibly even in house connections. Little Falls, N. J. sewage was checked for coagulant demand that same day upon completion of the work in Ridgewood and it was found that the raw sewage there coagulated successfully with 50 ppm. of aluminum sulphate to yield a crystal clear supernatant and a good quality floc. Therefore constant determinations of free CO_2, alkalinity and pH were made on

Clarifier No. 2 in foreground; in rear, sludge bed cover; extreme right rear, the digester



both water and sewage, but without revealing any changes in the water corresponding to those in the sewage. Marked variations were noted in the free CO_2 and bicarbonate alkalinity of the sewage and some changes in the pH, unrelated to the other two determinations. Study of the laboratory record of these determinations indicated that the bicarbonate alkalinity curve of the sewage paralleled the coagulation demand from hour to hour and that when the concentration of bicarbonate alkalinity was highest the coagulation difficulties were most acute. Acting on the assumption that the bicarbonate alkalinity content was either too high or that it was not in available form, pre-acidulation and the use of hydrated lime were again tried, but without success.

Finally it was decided to reverse the procedure of applying the H_2SO_4 by introducing the coagulant to the sample first and after the floc or reaction had begun adding acid. Remarkable results were immediately forthcoming, a "ball" of floc forming under the stirrer paddle. The supernatant was crystal clear, the floc tight and of good settleability. With the assistance of Col. W. A. Hardenbergh, of PUBLIC WORKS magazine, a technique for the proportioning of the acid was developed, based on the fact that the pH of the sample after complete treatment was almost invariably in the range of 6.0 to 6.8, when excellent coagulation was obtained. This seemed to indicate that the residual alkalinity (all bicarbonate in this instance) was a factor in determining the completeness of the reaction. Thus, given the initial bicarbonate alkalinity and the pH, it is easy to compute the alum dosage and acid necessary to make the alkalinity adjustment and ensure perfect coagulation. (It is interesting to note that this method was evolved at this plant independently and that Rudolf's work recently described in the Sewage Works Journal was not then known to any one connected with this plant.)

Several carboys of sulphuric acid were procured and plant scale application was tried out. Jar test results obtained in the laboratory were duplicated on wash day flow in the plant by application of 10 to 30 ppm. of H_2SO_4 to the "flocced" but incompletely clarified sewage in the flocculator.

A disconcerting aftermath to these coagulation experiments was the 60% decline of gas production in the digester, the absence of stratification and the poor appearance and drying quality of the digested sludge being drawn to the beds. Tests of pH on the raw alum-acid sludge averaged 6.4. Alum-acid procedure was discontinued and the amount of lime being added daily to the digester was increased from 25 lbs. to 100 lbs. for a period of 12 days, at the end of which time, pH determinations showed an upturn. Six weeks elapsed altogether before stratification was restored and gas production and sludge drying were normal.

Microscopic examinations of precipitate from straight aluminum sulphate and alum-acid procedure respectively were made to determine the effect of the acid procedure. Corroboration of the plant and plant laboratory test observations was the result, the straight alum floc being replete with bacterial and organic activity, whereas considerable exploration was necessary to find mobility or even intact cellular structure in the alum-acid floc. Both these samples were taken from the same grab sample of raw effluent.

Evidently a bactericidal effect attended the reaction obtained by post acidulation of the formed floc. Where raw or initial alkalinities are high (in this case up to 297 ppm.) requiring proportionately heavier applications of acid, and where biological processes are utilized to stabilize the sludge, it is evident that the alum-acid procedure should be used with caution. Distinct advantages, however, might accrue from post-acidulation in plants using non-biological methods for disposing of the sludge.

Further laboratory tests with various iron salts, plus post-acidulation procedure, yielded excellent coagulation results and clear supernatant.

By stirring a sample for 40 minutes instead of the customary 15-minute period adopted in standard laboratory procedure, it was discovered that the time of stirring was important in obtaining a complete reaction; 100 ppm were being applied in the plant with indifferent results at this time. The jar sample was treated with 100 ppm and the results were excellent; a good quality floc and crystal clear supernatant being obtained.

Split Alum Treatment

On June 15, 1937, acting on a reference contained in Ellms *Water Purification* (page 101) which described the successful application of this type of treatment to the badly contaminated Ohio River water at the Portsmouth, Ohio, plant. 70% of the alum dose was applied to clarifier 1 (Primary) and 30% at the flocculator (preceding clarifier 2). After a few days test this work was discontinued. No difficulty was experienced in forming a floc without mechanical mixing or paddling but about 30% more alum was required and the final effluent was not crystal clear. Since that time a comminutor followed by the customary U-bend effluent pipe has been installed. Hydrogen sulphite has been eliminated from the sewage by striking at its source. (The procedure followed in this will be described next month.)

Being unable to utilize the post-acidulation procedure because of its effects on sludge digestion and in view of the apparent importance of the time factor, it was recently decided to repeat the split dose treatment, utilizing the comminutor as a mechanical mixer. The same ratio of 70% primary and 30% secondary dose was maintained and excellent results at no extra cost were obtained. A make-shift arrangement consisting of a barrel was used for the preliminary work but a Wallace and Tiernan dry feed machine is now introducing the primary dose at the comminutor effluent. No deterioration in the effluent quality is now experienced during the hours of 10 A. M. to 2 P. M. and a crystal clear effluent is the rule. Whether the mechanical mixing by the comminutor, the elimination of Beggiatoa, and their reducing action of the sewage, or both, are responsible for the satisfactory results from the split dose treatment, is not known. High rates of flow and maximum strength sewage are now handled with little or no difficulty since the secondary floc resulting from split dose is of exceptionally good settleability. The double dose is necessary only during that part of the day when the peak flow and strength of sewage obtains. Using split dose treatment, the effluent for the first ten days of July was crystal clear for 198 hours and cloudy for 42 hours; the volume of sewage treated was 10,122,000 gallons; the total cost for alum $52.65 making the average cost per million gallons $5.26. It should be stated that cloudy effluent is the result of cutting too fine on the feed, but the trickling filter takes up the slack under such temporary conditions and produces a uniformly clear effluent.

[Further operating data, the procedure in eliminating Beggiatoa from the sewers, experiences in odor control and relationships observed between alkalinity and coagulation will be treated in succeeding issues.]

Cleaning walk

Safety in Sidewalk Maintenance

By HUGH B. RICE
Town Manager, Lexington, Virginia

Hugh B. Rice

Applying Lifekote Bond

Sprinkling, rolling and brooming surface

Finished surface

LEXINGTON, Virginia whose population is about 4,000 is the site of the Washington & Lee University and the Virginia Military Institute. The combined student population is about 1500. Besides these students and cadets and their friends, Lexington entertains thousands of visitors each year as it is aptly called the "Shrine of the Southland," for here is the final resting place of the two greatest Confederate Generals, Robert E. Lee and Stonewall Jackson.

Lexington has always built with permanency as its watch word, and as its population is made up of citizens whose ancestors were the conservative Scotch-Irish, it has always made the dollar go as far as possible. This axiom evidently was the keynote in the construction of a sidewalk along its Main street some 30 years ago. The contractor who put this walk down told me the main specification was, "we want a sidewalk that will not wear out." True, the concrete has not worn out but many a leg muscle has become cramped in trying to keep from falling on the extremely slick surface which was further polished by the continued walking of the thousands of students, cadets and visitors during these 30 years.

Several times the surface was chipped and other times it was treated with acid but within a short time it was again a menace to the pedestrian. Fortunately no one ever entered a suit to recover damages from personal injuries, for many had very bad falls.

In 1933 a trial section of approximately 100 square yards was treated with a material known as Unicrete. This proved quite satisfactory and in September 1937 the Council appropriated a sufficient sum to surface treat the entire length of the sidewalk which was put down "never to wear out."

After securing the manufacturer's specifications and suggestions as to methods of handling this material we began work on October 6. Realizing that cold weather and freezing conditions at night would hamper us to some extent we rushed the work with all speed to completion before November 1.

The manufacturer's specifications called for an addition of two parts Unicrete to a mixture of 1-2-4 concrete. The stone of which four parts was specified was not larger than ¼ of an inch but contained considerably more fine material than anticipated. This, however, served to reduce the sand proportion requirements and we believe gave us a more serviceable surface than could have been obtained with the local sand and gravel only.

The first thing necessary was repairing broken or disintegrated sections of concrete. This was done with a 1-1 grout, using a quick-set cement because of the weather conditions. Next the entire sidewalk was thoroughly cleaned by scrubbing with brooms and water, and in some cases a solution of acid was used to remove oily or greasy spots on the walk. The walk was then thoroughly flushed with water under fire hydrant pressure and then allowed to dry before the application of the Lifekote Bond was applied in accordance with the manufacturer's specifications. At this point it might be well to say that the application of the bond coat is very important as it really is the foundation for the application of the subsequent material. This was allowed to dry either over night or if the sun was strong enough it was in good shape in four or five hours, then the aggregate material was applied, the proportion of sand, stone and water being varied for securing not only the best grade of concrete but also to facilitate proper curing of the same.

After trying two or three methods we found the best way of placing, screeding and troweling was that of handling the operations across the walk rather than longitudinal with the walk. A one-bag concrete mixer was used and the material was hauled from the mixer to the sidewalk in wheelbarrows. The crew consisted of the following men:

1 foreman
1 mixer operator
3 men behind the mixer, one for stone, one for sand, one for cement and Unicrete
2 wheelers
1 finisher and helper

1 truck driver, who served as utility man when not hauling materials

The screeding and maintenance of uniform thickness of material was accomplished by placing two iron rods ⅜" in diameter across the walk and leveling the material with a metal edge board about 10 feet long. In other words, a section of about 8 feet long was put across the walk at each run. Adjacent sections were put down by merely moving the rods ahead and filling in the space with a small amount of material.

After the material was leveled off it was troweled down, removing any large pieces of rock and filling any voids and low places. It was then allowed to dry or cure for some time until it had reached such strength that a small roller (weighing 300 pounds when filled with water) could be put on it. A compact and thoroughly bonded surface was accomplished by sprinkling the top with sufficient water so that when it was rolled a resulting grout was worked into the voids and thin places. A corduroy surface was secured by brushing with a house broom.

It is believed that a most economical job was secured. Besides the labor as outlined above, the following equipment was used: one mixer, one truck, two small hand rollers. One morning due to atmospheric conditions it was necessary to use the air compressor and blow air on the surface to assist the setting up. The use of a 3-ply roofing paper protected the finishing surface from rain which occurred quite often during the time of the project.

The accompanying pictures will show the steps in construction as outlined above. The total number of yards of sidewalk covered was 2318 at a cost of $1,441.50. The total time between the beginning of the project and the completion was twenty-eight days, however, the actual working time was fourteen days due to weather conditions and Sundays. Although this work was not undertaken as a WPA Project we used extra men secured from the relief rolls. The Council feels that the amount spent was good insurance against personal injuries to citizens and it is planned that additional work of this nature will be undertaken in sections where the walks are becoming slick and dangerous.

Mapping Michigan Roads

The final maps which result from the Michigan Highway Planning Survey inventory of the rural highways and of traffic and the economic and cultural factors which produce traffic, will consist of several series covering each county of the state. All the maps will be drawn to the uniform scale of one inch to the mile and will be printed on a standard sheet size to form a complete road atlas of the state.

Outline series.—The first of the series is an "outline map." It consists of a layout of the measured roads, plotted accurately with reference to the established lines of latitude and longitude to conform to the earth's spherical surface. It contains the principal basic features, the names of political subdivisions, rivers, lakes, other drainage features, railroads, etc. On this series will be developed indexes of bridges, culverts, grade separations, railroad crossings at grade, and other appurtenances.

Base series.—The "base map" is built on the outline maps. It shows all such indications of cultural development as houses, business places, schools, and other items of development which are related to the highways and their service.

Transportation map.—On this map are recorded all items relating to transportation, such as road types, railroad terminals, harbors, navigable waterways, air lines and ports, and pipe lines.

School bus series.—This series will show what routes are used for transportation service to rural schools.

Postal series.—The final map in the series will designate all routes used in the postal services. These are the star mail and the rural free delivery routes.

Future county series.—Other series of maps are contemplated which will make further vital information available in this useful form.

a) Recreational map.—A map is projected which will contain all items pertaining to the development of resort and recreational resources. In Michigan, which is rich in developed and undeveloped resources of this kind, this will be a valuable contribution.

b) Traffic maps.—Traffic maps of each county are contemplated. These will indicate by symbol or flow band the average daily traffic on each mile of road.

How many different uses this whole series of maps will serve is hard to estimate. There have already been many evidences that the public is keenly interested in them, for maps showing physical and cultural features in such detail and with the desirable degree of accuracy have hitherto been nonexistent. These maps will undoubtedly be of great value to many public agencies and to many kinds of private business.

The Michigan Highway Planning Survey is preparing these maps to get on record the rural roads for which the public is responsible.—Harry C. Coons. A paper before the 24th Michigan Highway Conference.

Cotton Fabric and Asphalt for Road Shoulders

An innovation in the method of treating shoulders has been used in Rhode Island, which involved the use of a loosely woven cotton fabric furnished free by the Federal Government. The shoulder to be treated was first primed with about ½ gallon of MC-2 asphalt upon which the cotton fabric was immediately and evenly spread. Upon this one more application of MC-2 asphalt was used in approximately ½ gallon per square yard quantity and a final application of MC-3 of about 1-3 gallon per square yard quantity, each application being separately sanded. Approximately 8,000 square yards of shoulder surface were thus treated. It is anticipated that this treatment will greatly increase the stabilization of the shoulder surface and, in a large measure prevent the washing and gullying of the shoulders in heavy rains and spring thaws. The total cost of this method comes to approximately $0.216 per square yard, excluding the cost of the cotton fabric.

Right to Money Saved on Reletting Contract

A highway construction contract was cancelled by the State of New York for failure to make proper progress and relet to another construction company, which completed it. When the state relet the contract, the contractor bid lower prices than the state agreed to pay the original contractor. As a result about $5,000 was saved to the state. In an action against the state to foreclose liens on the improvement against money due the original contractor from the state, the New York Court of Appeals held this sum was no part of the moneys due either of the contractors or applicable to the improvement and as the lienors' rights necessarily depended on the contractors' interest in the fund, they had no claim to the money. (International Harvester Co. vs. Whelan, 274 N. Y. 162, 8 N.E. (2d.) 319.)

The Editor's Page

Factors in Chemical Treatment of Sewage

Continued research and progress in sewage treatment are bringing out factors of importance alike to the designing engineer and the municipality. First, it appears certain that chemical treatment can be developed to the point where, with proper operation, it will yield a remarkably clear and bright effluent. Second, a skilled operator is necessary for really satisfactory results, and such a man can earn his salary for the community. Third, if chemical treatment is employed on a 24-hour basis, considerable additional digestion tank capacity is needed. Fourth, better arrangement of flocculating and settling devices is required than now exist in most plants.

There is a large amount of information available on coagulation of water, but the data derived from this work do not apply in all details to sewage coagulation. Under conditions of poor flocculation in water purification, better results sometimes can be obtained simply by overpowering the water with a super-dose of coagulant. Generally speaking, that can't be done with sewage. The dosages required are large to begin with; sewage contains many times as much organic matter as water; reactions are not the same; in addition, there are unforeseen and undeterminable factors in sewage; and not only are there important differences among sewages, but any given sewage will vary from hour to hour.

Alkalinity affects coagulation; carbon dioxide apparently does not; other factors appear to require consideration. Adjustment of alkalinity or acidity after the floc begins to form, as has been developed at Ridgewood, N. J., appears to be a promising factor. Further study is needed, and experience at many plants. In the meantime, designers should give attention to some of the factors mentioned above when they are working on new plants.

Traffic Control by Colored Strips or Roadways

A red road surface means "slow down," but where the surface is green, the motorist can "step on it" right up to the legal limit. An English motorist and engineer suggested recently that such a scheme would be much better for controlling traffic than our present method of roadside signs. There might even be colored lanes or surfaces for leading motorists through cities—an extension of the idea used in New York subways, where one follows the green or red lights through the bewildering maze of underground passages.

And, of course, the "slow" traffic lanes on highways could be colored to keep slow-moving vehicles to the right, though the pessimist will say that this won't be much improvement because the drivers of such vehicles. now apparently unable to read, will prove to be color blind also.

It is suggested also that a red band across the exits of one-way streets might help to keep drivers from attempting to enter these. As compared to the advertising signs that are so common, our directional and warning signs are exceedingly coy and modest—shrinking violets, we might say, so long as we are talking in terms of color. A good driver doesn't let his eyes wander far from the road surface, and fewer would miss the red band warning and other directional colors than the usual signs used for the purpose.

Water Supply for the Army

These days the newspapers are so full of war news and war scares that Mr. W. W. Engineer and Mr. O. P. Rator can hardly help but think of the part that they may yet be called on to play. In other parts of the world armies numbering millions are in the field, and to engineers there the problem of providing a safe and pure water for them is no minor one.

Mobilization means the gathering together of men in camps or cantonments—as a rule from 10,000 to 30,000 in one area. Water must be supplied for these men, and usually the supplies in that particular area are neither large enough nor near enough to provide adequately for them. Therefore, supply systems and treatment plants must be built and built quickly to serve them. An army of a million men will mean 60 to 75 cantonments, and nearly that many new water plants.

Armies do not fight in a built up area, well served with water mains, without wrecking those mains and supplies; and if they fight in rural areas, they are also without adequate water. So it can be assumed that armies in the field must be provided with water especially obtained and made safe for this purpose. An army of 325,000 men may occupy an area of some 1,000 square miles, and the provision of water for these men and the accompanying animals (10 gallons per head per day for horses and mules) will be a problem. Pipe lines, tank trucks and local supplies must combine to solve the problem.

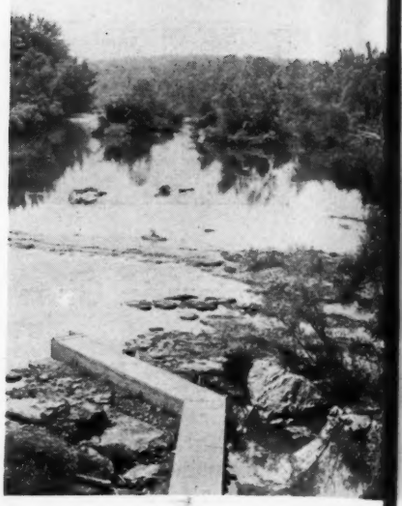
Getting water up to the front line is another problem. Pipe lines cannot normally be brought nearer than 5 miles to the front line. From there on it means haul and carry, with the last mile to the outpost line hardest of all. Water is heavy and awkward to carry. A battalion of soldiers (about 700 men) will need about 2,000 gallons per day minimum. With the enemy making it as difficult as possible, this water must be brought up by mule tank from the rear—and how much can a mule haul and how far can he travel from dark to dawn? Such a unit would normally be served by 4 tank trucks, each of 100 gallons capacity, which means that each mule must take four or five round trips during the night.

Army water supply offers a big field for new devices, for it is one of the big problems, once a nation is committed to arms. The above resume covers only a few of the problems, not including the job of producing a safe and attractive water under the most trying of conditions.

Revamping an Old Filter

By D. Y. McDOWELL
Superintendent of Waterwork, Malvern, Ark.

D. Y. McDowell



Intake on the Ouachita river during low w

OUR water troubles began back in 1924 when the Arkansas Power and Light Company built their first hydro-electric dam on the Ouachita river, our source of supply.

Prior to the construction of this dam, the Ouachita was a lovely mountain stream flowing at a rapid rate, from its source in the Ouachita Mountains to just a little distance below our intake, at which point its speed slows down, due to the leveling off of the land through which it flows. Under these conditions it cleared quickly after even the heaviest rains, and by keeping our settling basin full we could suspend pumping until the turbid waters had passed our intake.

Our filter plant was built in 1920 and was designed to operate under these favorable conditions. It naturally was not a very efficient plant as it was required to do little work. We had no mixing chamber and no mixing equipment except two 150-gallon solution tubs.

But when the hydro-electric dam was built, our troubles began. This 60-foot dam created Lake Catherine, a lake 12 miles long, some seven miles up stream from our intake. The lake is a wonderful recreational center and a fisherman's paradise, but with it began our turbid water troubles, as well as discoloration due to decomposing vegetable matter in the lake—and this instead of the clear sparkling mountain stream water to which we had been accustomed.

Then in 1931 the power company completed a second hydro-electric dam, at the upper end of the first lake, which dam is 110 feet high as against 60 feet for the first dam, and created a lake twenty-four miles long, thus giving us 36 miles of still-water troubles.

Then in 1933, as though we hadn't enough troubles already, a mining concern opened up a titanium mine in the world-famous (famous because it contains a greater number of minerals than any territory of like size in the world) Magnet Cove district. In their operations they pump 600 gpm for twenty hours each day, and this wash water finds its way to the river below the first dam, and about six miles above our intake. This wash water with its various minerals in solution and volcanic ash in suspension—almost colloidal—pollutes our formerly nice little mountain river until it looks more like something the hogs had just waddled out of than something from which to take a city's water supply.

Reconstructed filter building

These conditions naturally kept growing worse with the raw water until we had muddy—or turbid, if you like it better—water in our distribution system. Finally the State Board of Health chief engineer, M. Z. Bair, made a survey, and recommended that we revamp our filter system. As a result, late in 1937 we entered into a contract with Morey & Morey, engineers, Dallas, Texas, to furnish the equipment and advise with us as to installation and operation.

Following the advice of the state chief engineer and our Dallas engineers, we cut off a section of our sedimentation basin and made it into a mixing chamber. In this, we installed a constant-speed vertical rotary mixer to operate at six revolutions per minute. Operating at our average rate of flow of 120,000 gallons per day, the mixing chamber has a detention period of thirty minutes.

With their discharge pipes flowing into the mixing chamber, we set up a battery of three dry-feed machines; one each for aluminum sulphate, carbon and lime. Later, due to the low alkalinity and pH of the finished water, we had to move the lime feeder so as to add the lime to the water after filtration to prevent red water and to keep down corrosion in the distribution system. The average dose of chemicals is as follows: Aluminum sulphate, 2 grains per gallon; activated carbon, ½ gpg.; lime, 1 gpg. The normal alkalinity and pH of the raw water are 26 and 7.2, and of the filtered water, 34 and 8.3.

Upon investigation, we found our rapid sand filters to be made up of about one foot of crushed rock of about one-inch size, irregularly placed over the under drain system, and an inferior grade of sand. We replaced the crushed rock with eighteen inches of correct sizes of gravel—the larger sizes hand picked—ranging in size from 2½ inches down to torpedo sand, and topped this with 27 inches of filter sand as approved by the State Board of Health. There are two filters, each 10 x 12.5 ft., giving a total filter area of 250 sq. ft.

We then reworked our old filter building superstructure, which had been built of the form-lumber used in the construction of the concrete filter and sedimentation basin. We now have a fairly modern plant that looks well and turns out a safe (of course our water is chlorinated), good looking and good tasting water.

P. S.—Just as we go to typewriter (not press) word reaches us that the power company is soon to start a third dam, which will add 35 miles more of still water; but let 'em go, we can take it, NOW.

YOU BET, THE TIRES MAKE A DIFFERENCE!

On a Kansas road job this LaPlant-Choate scraper, equipped with Goodyear All-Weather tires, is averaging 6½ yards per trip, or roughly 100 yards per hour — *a lot of pay dirt!*

SAVE *with the right tire for your job*

Goodyear PNEUMATIC LUG for rough rocky going

Goodyear SURE-GRIP for mud, sand and soft ground

Goodyear ALL-WEATHER for all-round service

IT REALLY is surprising how much difference the *right* tire makes in speeding up operations and cutting job costs. That is the reason why so many contractors specify Goodyear tires on all types of equipment—*Goodyear makes the right tire for every job.*

For work in rocky broken country you can get a Goodyear specially armored with massive lugs to prevent cutting and gouging. For operations in deep mud and sand there's a Goodyear with a powerhouse tread that pulls through anything. And for all-round service the famous Goodyear All-Weather gives longest-wearing road-holding traction.

Whichever Goodyear fits your need will give you long dependable service because all are built with patented Supertwist cord *in every ply* for extra strength and protection against blowouts. That is why on the hard jobs you find more Goodyear tires than any other kind. Put on the right Goodyear and watch your mileage jump!

THE GREATEST NAME IN RUBBER

GOODYEAR

MORE TONS ARE HAULED ON GOODYEAR TRUCK TIRES THAN ON ANY OTHER KIND

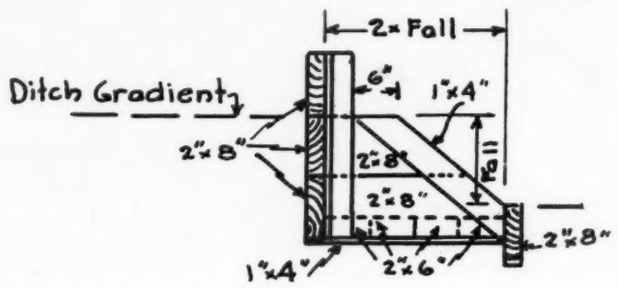
When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 71-73

Highway Ditch Checks Should Be Installed When Road Is Built

By W. A. STACEY

IN HIGHWAY work, ditch gradients are generally fixed by the corresponding grades of the road surface. In such work, the problem of control of erosion in roadside drainage depends upon two factors, velocity the discharge can often be reduced to a safe amount on light grades by using flat-bottom ditches instead of V-shaped ditches. The latter tend to increase the discharge velocity by concentrating the flow in a small area, whereas the former tend to reduce it by spreading the water over a larger area.

For the steeper grades, however, the prevention of scour is best accomplished by building a series of checks into the ditch bottom, so that the water goes down by a series of small falls, while the ditch grade between the



checks is flat enough to eliminate erosion in that particular type of soil. In some soils, the grade of the ditch between checks must be held to less than 1 per cent. The Arkansas State Highway Department restricts the slope on light soils, easily eroded, to one-half of 1 per cent. On some heavier soils, the grade may be increased to as much as 2 per cent without serious scouring.

In general, it is better to control the side ditches with a larger number of small falls of 9 to 12 in. each, rather than by a lesser quantity of greater falls. For one reason, the resultant ditch grade will more nearly parallel the road grade and can be more easily mowed and maintained. For another reason, should a check be washed out, less damage will occur from the loss of a smaller check than from a larger one.

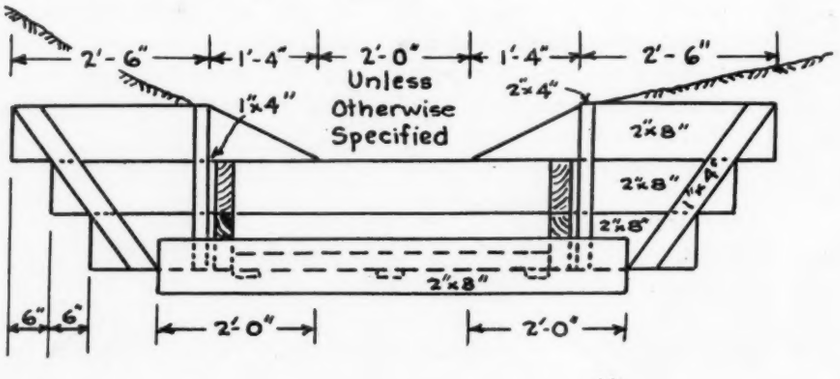
In the past, there has been a tendency in some localities on new highway work to leave the problem of controlling ditch erosion to the maintenance forces. In most cases this procedure has proved to be a costly mistake. The run-off from several heavy rains sometimes erodes portions of newly built roads so that the cost of repair thereon exceeds many times what it would have cost to install ditch checks in the original construction contract. The maintenance forces, moreover, may approach an aggravated erosion situation with haphazard methods and nondescript materials, because of inadequate time and funds.

The proper time for placement of ditch checks is, therefore, during the period of construction, when the ditches are being built to uniform dimensions, when the character of the soil is revealed before erosion losses have started, and when the building of checks can be done cheaply in quantity in accordance with a standard plan. On one project in Georgia in 1932 about 2,000 ditch checks of pressure creosoted lumber were placed at a cost of about $3.00 each, or $0.22 per lineal foot of ditch so protected. This was considered a very nominal price compared with that of a flume or other methods of protection. After 15 months of service, it was found that only 17 of these had washed out. In the case of a treated timber check, a washout can be readily repaired because of the nature of the material involved.

The type of creosoted wood check used in Georgia and Arkansas is generally built with ordinary dimension lumber; 1 to 2 in. thick and 4 to 8 in. wide, framed before treatment. The Arkansas standard has a total length of about 10 ft., a weir opening of 4 ft. 8 in., a fall of 1 ft., and a stilling basin 2 in. deep, with a width of twice the fall. The lumber therein has been treated with creosote to a retention of 10 lbs. per cubic foot by an empty-cell process.

The rule for the replacement of these checks is illustrated by the following example: Assume a road grade of 4 per cent, a soil condition that will withstand erosion up to a 1 per cent ditch gradient, and a standard check of 1 ft. fall. Then the total fall to be provided for with the checks in each 100 ft. of ditch is equal to 4 minus 1, or 3 ft., thus requiring 3 checks spaced about 33 ft. apart.

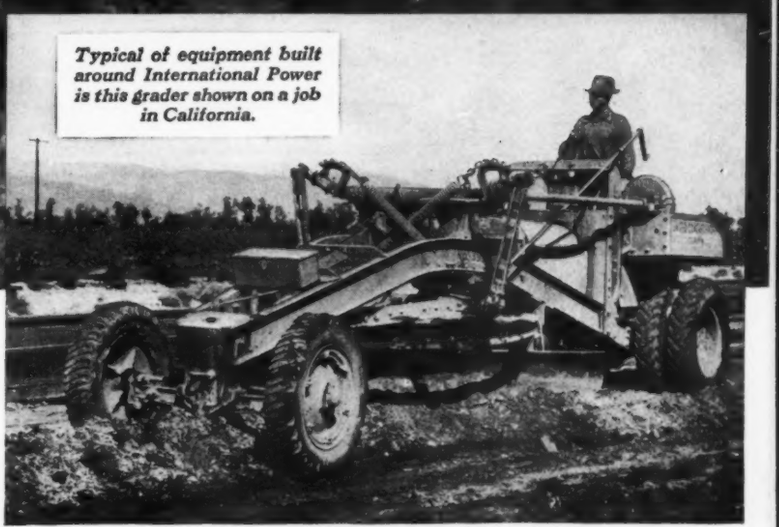
*From Wood Preserving News, with slight changes.



ACTION ON THE JOB . . .
PROFIT ON THE COST SHEET . . .
with INTERNATIONAL Power

When you move the earth rely on International TracTracTors to save money for you. This is Model TD-40 Diesel moving dirt fast with a 4-wheel scraper.

Typical of equipment built around International Power is this grader shown on a job in California.

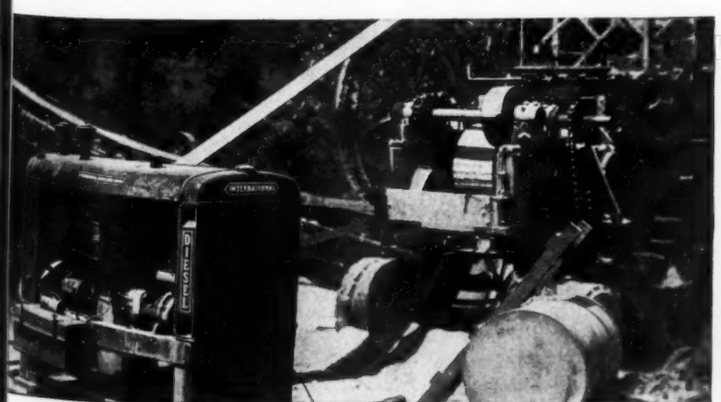


• Great working capacity, low-cost operation and maintenance, long life—these make investment in International Power unusually profitable. The tougher the job the greater the need for International TracTracTors, Wheel Tractors, or Power Units. These International Harvester *quality* products are engineered in every detail to give *plus* performance and to cut costs to the bone.

Solve your power problems with International Power. If you need sure-footed crawler power, specify TracTracTors—available in five models for gasoline and Diesel operation. International Wheel Tractors are built in several sizes, gasoline and Diesel, with steel wheels or pneumatic tires. There are eleven International Power Units ranging up to 110 max. h.p. for gasoline, Diesel, and gas. Scores of manufacturers build high-grade equipment around these tractors and engines, making it possible to apply their power on an amazing variety of jobs.

The nearby International industrial dealer or Company-owned branch will give you complete information on how International Industrial Power can make money for you.

INTERNATIONAL HARVESTER COMPANY
(INCORPORATED)
180 North Michigan Avenue **Chicago, Illinois**

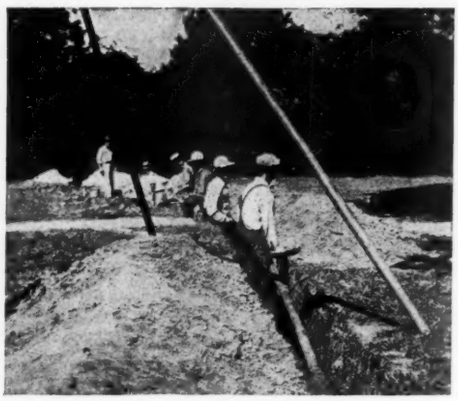


This International PD-80 Diesel Power Unit saves $5.30 a day for the owner of this rock crusher compared to the power it replaced. It has also increased production 75 to 100 cubic yards a day.

The International ID-40 Diesel Tractor provides the economy of the International Diesel engine where a wheel-type tractor is wanted.

INTERNATIONAL Industrial Power

2" CAST IRON PIPE HAS NO EQUAL



CORROSION RESISTING

get PERMANENCE

LASTS FOR CENTURIES

Make sure the *small* water mains you lay today are good for 100 years of trouble-free, revenue producing service. For it takes no longer to lay *permanent* mains with

McWANE 2" CAST IRON PIPE

than a short-lived substitute—and the cost is practically the same. There is no substitute—no equal—for this *corrosion-resisting* pipe with its factory made joints that can be

Quickly INSTALLED

with unskilled labor. Yes, McWane 2" Precalked Pipe needs no lead melting or pouring on the job. The joint materials are shipped in the bell—just socket and calk! Shipments now from stock. Precalked Fittings!

Sand Cast Inside and Outside

McWANE

CAST IRON PIPE COMPANY

BIRMINGHAM, ALA SIZES 1¼" THROUGH 12"

Chicago, Dallas, Denver, Kansas City, New York, Portland, Ore. Salt Lake City, San Francisco, Los Angeles

When writing, we will appreciate your mentioning PUBLIC WORKS.

Water Consumption Rates in American Cities

WHAT is the average per capita water consumption in the United States and is it increasing or decreasing? This is one of the questions to which a fairly correct answer can be found in a recent report of the U. S. Department of Commerce. The tables given therein are compiled from data furnished by 434 of the 486 cities of the country that have 20,000 population or more. Of these, however, only 385 gave consumption statistics; but these 79% of all cities should give a fairly good idea of the entire number.

We find that 81-90 gal. per capita was reported by fifty-four cities as the "average daily delivery" in 1936 (the last year reported). Next in order, with forty-five cities reporting each, were 91-100 gal. and 111-125 gal. Following in succession were: forty-four cities with 71-80 gal.; thirty-nine cities with 61-70 gal.; thirty-six cities with 126-150 gal.; thirty-five cities with 101-110 gal.; thirty cities with 51-60 gal.; fourteen cities with 151-175 gal.; eleven cities with 26-50 gal.; and nine with 176-200 gal. Two were under 25 gal. and twenty-one were over 200 gal.—a few way over, these twenty-one averaging 290 gal.

Omitting from the computation these unusually high and low figures (some due to seasonal increases in population, extensive irrigation use, and other abnormal conditions), we find the average to be 95 gpd—a close approximation to the 100 gpd which is frequently assumed as an estimate on which to base plans. However, it should be noted that 36% of the cities exceeded 100 gpd.

These figures are given, not as domestic consumption but as total water delivered, including that not accounted for.

As to increase or decrease in consumption, the depression apparently has played such an important part in this that recent figures furnish no criterion for the future. In 1932, 78% of the cities furnished less water than in 1931, the maximum decrease being 25.4%. On the other hand, 20% reported increased consumption over 1931, the maximum being 39%. The next four years showed recovery in many cases; and for the five-year period 1932-1936 only 24% showed less consumption in the latter year than in 1931, the maximum reduction being 28.9%. Most of the others showed an increase, Attleboro, Mass., 86.3%.

In view of Attleboro's record, it might be interesting to examine more of the data for this city, whose population was 20,000 in 1936. Its consumption increased 33.9% in 1932, 25.3% in 1933, 3.9% in 1934, decreased 2.8% in 1935, and increased 10.0% in 1936. Its total "water delivered" in 1936 was 422,230,000 gal., and it has a storage capacity of 216,530,000, or more than 6 months' supply. The supply is partly surface and partly well. The pumping capacity is adequate to meet a 300% increase in the present demand and its treatment plant a 330% increase. The temperature of the water at the main outlet averaged by months in 1936 for the months of April to September inclusive, was 48.3°, 53.0°, 59.6°, 64.3°, 68.7°, 67.0°.

In many cities the water temperature during the months named rose above 80°; 93° in July in Kansas City, Kans.; 90.7° in August in Muskogee, Okla.; 91° in July in Shreveport, La. These are monthly averages; probably on individual days the temperatures rose still higher.

Sources of Supplies

Among other data in this report are tables of the sources of supplies of the different cities. Of 396 cities

furnishing this information, 256 use surface supplies, 98 use well supplies, and 42 use both. In general, wells are favored by the smaller communities, although one city of 500,000-1,000,000 population and two of over a million use well supplies. Of 102 cities of 20 to 30 thousand, 56% use surface supplies, 44% wells. Of the 68 cities of 30 to 40 thousand, 70% use surface supplies. Of the 45 cities of 40 to 50 thousand, 67% use surface supplies. Of the 75 cities of 50 to 75 thousand, 72% use surface supplies. Of the 34 cities of 75 to 100 thousand, 65%; of the 41 cities of 100 to 150 thousand, 70%; of the 26 cities of 150 to 250 thousand, 89%; of the 25 cities of 250 to 500 thousand, 70% use surface supplies.

Contemplated Water Works Construction

A number of cities have furnished PUBLIC WORKS with information regarding proposed water works construction, and practices in connection with water works operation. Among the items proposed by them for early construction are 20 swimming pools, 19 filter plants or additions or improvements thereto, 6 iron removal plants (some in connection with filtration projects) and 6 softening plants. Pipe lines contemplated included 118,956 feet of 2-inch and smaller pipe, 113,923 feet of mains under 6-inch, 631,882 feet of 6 to 12-inch mains, and 263,372 feet of mains 12-inch and over. This information was obtained through a survey by PUBLIC WORKS Magazine.

Also, 1522 fire hydrants, 15,877 service meters, and 3509 gate valves were included in the returns from the survey.

Creve Coeur Builds Water System

Municipal enterprise is exemplified by the village of Creve Coeur, Ill., in the construction, with labor provided by the Works Progress Administration, of a complete water plant, and the installation of a modern fire system. This village, which had a population of 350 according to the census of 1930, counted a population of more than 3,000 in 1936, and called itself the "fastest growing village in the United States." William C. Ruge, its President, formulated a program for a water and fire system in that year, proposing that the village raise $65,000 for materials and supervision by the sale of water revenue bonds and that the WPA provide the equivalent of $80,000 in labor.

Various delays prevented the opening of bids on the materials until the summer of 1937, by which time it was found that previous estimates were too low, so the village agreed to finance the project to the extent of another $10,000, making its share of the project $75,000 in all.

The new water system, the water having been tested and found pure by the State Health Department, began operation at the end of July this year. The system includes a 100,000-gallon elevated tank, which cost $11,800, and a pump station with a 250-gallon per minute capacity.

At the time of the opening of the plant, approximately 70,000 feet of water mains had been laid, with ample provision for future expansion of the system. A total of 725 service connections had been made, and 70 fire hydrants were installed. A volunteer fire department was organized and equipment, including a complete supply of hose, was purchased. All domestic users of water are billed at a flat rate of $1.66 a month, subject to a 10 per cent discount if paid before the 15th of the month.

Another Big Paper Mill
SELECTS LAYNE WELLS AND TURBINE PUMPS

WITH a capacity of 18,000,000 gallons daily, three Layne designed, drilled, and turbine pump equipped wells now serve the Brunswick Pulp and Paper Company's newly erected Brunswick, Georgia, plant. These Layne wells were successfully passed through, and cemented against, bad water formations,—a task that required much skill and care. Special equipment was necessary to core through hard limestone formations for the setting of full size, 3/8 inch thick by 18 inch diameter, welded continuous steel casings. The casings were then cemented at the bottom to the Eocene formation.

AFFILIATED COMPANIES

LAYNE-ARKANSAS CO. . STUTTGART, ARK.
LAYNE-ATLANTIC CO. . . . NORFOLK, VA.
LAYNE-CENTRAL CO. . . MEMPHIS, TENN.
LAYNE-NORTHERN CO. . MISHAWAKA, IND.
LAYNE-LOUISIANA CO. LAKE CHARLES, LA.
LAYNE-NEW YORK CO. . NEW YORK CITY, AND PITTSBURGH . . . . . PA.
LAYNE-NORTHWEST CO. MILWAUKEE, WIS.
LAYNE-OHIO CO. . . . COLUMBUS, OHIO.
LAYNE-TEXAS CO. . . . HOUSTON AND DALLAS . . . . . TEXAS.
LAYNE-WESTERN CO., KANSAS CITY, MO. CHICAGO, ILL., MINNEAPOLIS, MINN. AND OMAHA . . . . . NEBRASKA.
LAYNE-BOWLER NEW ENGLAND COMPANY, BOSTON . . . . . MASSACHUSETTS.
INTERNATIONAL WATER SUPPLY, LTD., LONDON . . . . . ONTARIO, CANADA

So again Layne does an outstanding job on a difficult undertaking.

Industries or municipalities contemplating the installation of a new water supply system, or seeking a reduction in water costs, may obtain valuable information by addressing Layne & Bowler, Inc. Here they will be guided by the World's most respected Deep Well water production experience. And, of course, Layne Pumps are equally well known for their records of high efficiency, long life, and low cost. For literature or consultation, without obligation, address LAYNE & BOWLER, INC., DEPT. W, Memphis, Tenn.

LAYNE

PUMPS & WELL WATER SYSTEMS
For Municipalities, Industries, Railroads, Mines and Irrigation

When writing, we will appreciate your mentioning PUBLIC WORKS.

Planning and Organization for Snow Removal and Ice Control

SNOW storms come, often with no warning or with a short advance notice only; the duration of the storm is uncertain; the amount and kind of snow (as dry or wet) and the wind conditions cannot be foretold. After the snow has commenced to fall there is no time for getting appropriations, purchasing or renting equipment, hiring men and preparing sound and workable plans. Therefore detailed advance planning and preparation are absolutely necessary, and such plans and preparation must be sufficiently flexible so that they can be adapted to a light, medium or heavy fall, and to other conditions as well.

Cooperation should be established with the Weather Bureau. For large cities and for sections of states, reliable forecasts can be made as to time, duration and intensity of storms, and probable temperatures. There are Weather Bureau offices in large cities, which receive and plot reports. Such data are not available for small cities, villages, counties and townships, and these therefore must base their predictions on general reports only.

A survey of equipment should be made in the summer or early fall; needed repairs to equipment should be made; the needs for new equipment determined; requests for appropriations made; and equipment purchased. A truck or plow that fails at a critical moment is worse than none. The most costly piece of equipment is the one that is not available to do its work when it is most needed. Attempts to use worn out or obsolete equipment for one more winter is a cordial invitation to improperly handled storms and public criticism.

Taxpayers expect that tax monies will be spent; they also expect that highways and streets will be opened promptly and kept open and safe for travel. Modern business requires that roads be kept open; in fact it pays in increased gasoline tax income alone to keep main roads open.

Finally, a good organization without good equipment cannot do satisfactory work. Adequate and stormworthy plows, trucks and tractors must be available or the whole plan fails.

In planning the work, the purposes and aims in snow removal must be borne in mind. The following quotation from *Public Roads,* published by the U. S. Bureau of Public Roads, emphasizes the importance of various phases of the work:

"Although the primary purpose of snow removal is to enable traffic to move with facility and safety, prompt removal also helps preserve the road surface and shoulders. The snow should be pushed back from the shoulders to facilitate the flow of water from melting snow into drainage channels. Failure to remove snow from the shoulders, and allowing a thin cover of snow or ice to remain on the surface, results in erosion on low and intermediate type surfaces, and loss of supporting value. The water from thawing snow and ice frequently runs along the edge of the pavement, softening the shoulders and allowing seepage under the pavement and into the subgrade. This excess water may serve to build up ice layers with resulting frost heave and often cannot drain away through the ground because of an impervious layer of frozen soil below. The weakened road may quickly fail under traffic, especially at the edges of flexible-type surfaces. It is now generally recognized that it is less expensive maintenance for snow removal crews to preserve the road by draining the traveled way during each thaw than to repair winter-damaged surfaces and shoulders."

Phases to Be Covered by Plans

A map of the county, city or township is desirable. (Villages are normally small enough so that maps are not a necessity.) These maps may indicate by colors the roads to be plowed first; and by districts the area that each gang or unit of equipment is to handle. Routes can be laid out on them. They afford a visual and visible perspective of the problems to be solved. U. S. Geological Survey maps may be used, but in most cases these no longer show roads correctly, as many changes have taken place since surveys for them were made. A scale of 1 inch to 1 mile is satisfactory for most counties and townships.

Organization.—In the city, snow fighting organization is frequently built upon the framework of the street cleaning department, and its personnel and trucks are employed for the work. Sometimes the street cleaning superintendent and his principal assistants are in charge, but draw on other divisions for personnel and equipment. In small cities, the city engineer, superintendent of public works or street superintendent takes charge of the work and uses any city equipment available.

In states, the maintenance organization is normally responsible for snow removal. In counties, either the county engineer or his assistant in charge of maintenance; in towns or townships, the highway supervisor (in New England often the selectman) has charge and employs town highway equipment.

Thus snow removal organization is based on a going organization; the problem is to expand this organization and provide it with the necessary equipment to do the work.

Equipment.—Based on the needs for each type of road, the basic equipment—the plows—should be allotted and reserves set up. Thus, on the main highways, speedy one-way truck plows will be used; on rural roads that do not permit high speed and where drifts may pile up in advance of the arrival of the plows, V plows on heavy trucks must be used; for city work reversible plows, graders, maintainers and even bulldozers are available.

It is a basic requirement that every important fighting force should have a reserve. The front line equipment is allocated to the road system, and an adequate reserve is then provided. If plows are new, a smaller reserve is safe; but accidents and delays always occur. The type of roads, the severity of snowfall expected, the condition of the equipment, the supervisory skill and the quality of the operating personnel are all factors.

Amount of Reserve Equipment:—In an area as large as a state, extreme snowfall over the entire state at one time is unusual. Therefore, "a state should equip itself fully for average or a little worse than average conditions. This means that in open winters they will be overequipped and in extremely hard winters somewhat underequipped, making necessary transfer of units from other parts of the state where conditions are

not so severe."—W. H. Root, maintenance engineer, Iowa State Highway Commission.

When it comes to counties, townships or municipalities, such transfer of equipment is not possible, because storms usually extend over the whole area. Therefore a reserve is necessary. This may be stated as the amount of equipment necessary to handle the greatest expected snowfall; such falls occurring infrequently there is sufficient reserve for all normal snowfalls.

Another method of procedure, and an excellent one, is to provide the snow plow equipment that is likely to be needed; and then to provide one extra "V" plow and one extra "one-way" plow for each five units or less of each type. Thus where a county has ten plows, there would be one "V" and one "one-way" in reserve; and for each group of 5 more plows, one more reserve unit should be supplied. One complete moldboard should be on hand for each 10 or more plows. Small attaching parts often can be repaired locally, but a spare moldboard or a supply of cutting edges will often prevent delay.

Motive Power.—The trucks and tractors that belong to the city, town or county are, of course, allocated to the work, but it is unusual when these are sufficient in number to handle the work. Trucks normally must be hired from contractors, trucking companies and others. All arrangements for securing such equipment must be made well in advance; the trucks must be of the proper size to handle the equipment; attachments for the plows must be placed on the trucks; and plans made so that the proper size truck for the plow is equipped with the correct attachments. Only trucks in first class condition should be hired. Failure of a truck ties up a plow also, and in a severe storm there are rarely enough plows.

Supervision.—As already stated, the man in charge of the work is usually a permanent employe engaged in construction, maintenance or street cleaning. Foremen or supervisors are usually also drawn from permanent personnel, but there are not always enough of these available, when work must be carried on during 24 hours a day. In such cases men from other departments or former workers may be used.

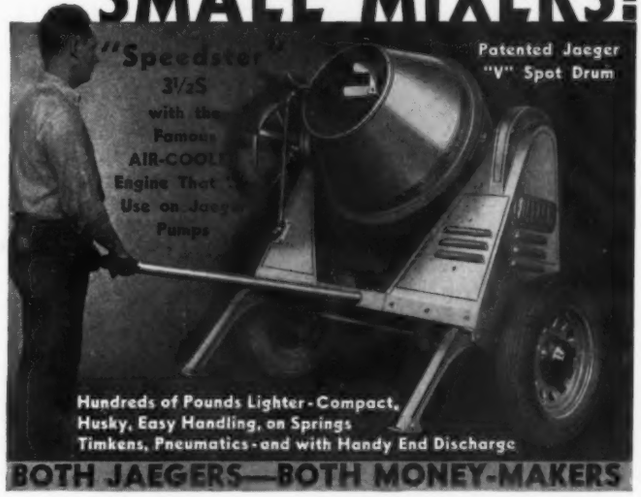
The district method of organization lends itself best to this phase of the work. When advance plans have been prepared, a list can be drawn up showing each district, its supervisor and the general foremen for each shift. These men then know what they will be called on to do, and can be prepared by conferences and written instructions, in as much detail as desired for their work.

Personnel.—Not much hand work is required, except in cities where snow must be removed; therefore the number of laborers required is not large. Trucks are usually hired with drivers included. One or two extra men should ride on trucks or tractors engaged in snow removal work. And when two or three shifts are used, the number of men increases. Personnel for such work is usually available from the part-time employes of the township, county or state maintenance forces. There are normally a considerable number of these employes who work only during the summer but are available for snow removal work.

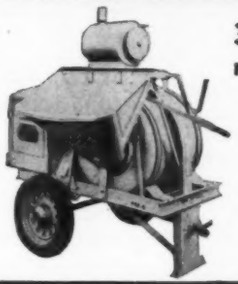
In cities, where large numbers of men must be mobilized for handling severe storms, labor agencies and the general floating labor groups must be relied on for personnel. Any advance training of these men is impossible; therefore the operating organization of foremen, equipment operators, timekeepers, clerks, etc., must be trained to provide direction.

Many of the laborers who are hired lack proper foot-

BIGGEST NEWS IN SMALL MIXERS!



BOTH JAEGERS—BOTH MONEY-MAKERS



3½S UTILITY WITH MEASURING BATCH HOPPER

Fast as a Power Loader—Up to 40 Yds. a Day

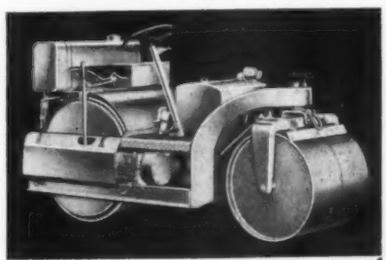
Load next batch while you mix and discharge — no waiting — 30% to 40% more yardage daily, all your job can handle. Saves you about half the cost of heavy 5S Non-Tilts. Get new catalog and prices.

THE JAEGER MACHINE COMPANY
400 Dublin Avenue Columbus, Ohio

C.H.&E.

2 AND 3 TON ROLLER

For rolling Playgrounds, Tennis courts, Driveways and patch work.



Send for catalog on Saw Rigs, Pumps, Hoists, Elevators, Mortar Mixers, Bar Benders and Cutters, and Rollers.

C. H. & E. MANUFACTURING CO.
3841 NO. PALMER ST. MILWAUKEE, WIS.

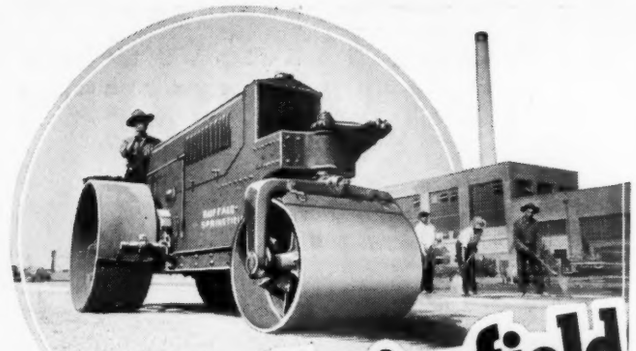
The Smith AIR COMPRESSOR
• Made from FORD PARTS

You'll SAVE MONEY with this low-priced, husky compressor—internationally used in the Construction Industry for efficiency and economy. It replaces expensive, cumbersome compressors on a majority of all work. Delivered as a complete unit or the Smith Compressor Head with instructions for mounting.

Write TODAY for complete information. Address Desk C.

GORDON SMITH & CO. Inc. Bowling Green, Ky.

When writing, we will appreciate your mentioning PUBLIC WORKS.



Buffalo Springfield

Modern construction work demands modern equipment... Buffalo-Springfield's up-to-date and complete line of Road Rollers can solve all compaction problems by economical and unfailing performance.

Made in 12 Models, from 2 to 21 TONS—
TANDEM—3-WHEEL and 3-AXLE TANDEM
GASOLINE OR DIESEL POWERED
Full details will be sent upon request...

THE BUFFALO-SPRINGFIELD ROLLER Co.
Springfield, Ohio, U. S. A.

Check in at DeWITT OPERATED HOTELS

In CLEVELAND it's The HOLLENDEN

In COLUMBUS it's The NEIL HOUSE

In AKRON it's The MAYFLOWER

In TOLEDO it's The NEW SECOR

In JAMESTOWN (New York) it's The JAMESTOWN and The SAMUELS

and featuring

Unusually Comfortable, Modern Rooms; Good Food, Carefully Prepared and Served; Every Modern Hotel Facility and Reasonable and Uniform Rates

"Genuinely Friendly"

When writing, we will appreciate your mentioning PUBLIC WORKS.

wear and clothing for the work. Rubber boots or other heavy covering for the feet, mittens, ear coverings and warm clothing should be provided, either directly or through relief organizations.

Routes and Schedules.—A basic requirement of the work of snow removal is that every unit, individual, plowing crew or equipment operator must know where to go, what to do, and what to keep on doing, when notified to begin snow work.

This means that routes and schedules must be prepared beforehand, and that this be done so that the more important streets or routes are opened first, so that all streets or roads are covered, and so that assignments are of the proper length.

The principles are the same whether the plan is for a city, or for a county or township road network. Even the application of the principles is not markedly different.

The first step is to mark the important routes, that are to be opened first. Divide these into sections small enough so that one plow can handle the work even in severe storms; or if desired, districts can be formed on other bases. In less severe storms, one unit can cover two districts, the other unit being held in reserve.

The essential part of the plan is to have a clearly understood job for every piece of equipment—where it should report, what it should do when it gets there; next job, next job, etc.

Cooperation.—Bus lines, street car lines and sometimes even truck lines do some snow plowing or removal. These companies should be interviewed, their plans studied and these coordinated with the city or county plan.

Preparing for Ice Control

The areas that need to be sanded when ice forms on the roads include hills, intersections, traffic lights, curves, railroad crossings and some overhead crossings and bridges. These must be located and should be spotted on the map.

Storage for the non-skid material—usually sand or cinder mixed with calcium chloride or salt—must be provided. For an intersection or short hill a small amount only is needed and may be stored in a box. On a long hill a number of storage piles are needed, if hand spreading is to be employed. But under such conditions, truck application is more common.

For the small areas where spreading is by hand, provision must be made for someone to spread it—sometimes street cleaning employes, policemen, etc. For the areas to be covered by trucks, routes and sources of supply of material must be planned for and provided.

Not as many trucks are normally needed for ice control as for snow removal; and since both jobs are not carried on at the same time, equipment that is ample for snow removal will also be ample for ice control.

Routes must be planned for sanding crews. These should be of such length, preferably, that they can be covered with one load, and refilling points should be available relatively near at hand. Thus planning consists in having available, at one or more convenient points, supplies of cinder or sand already mixed with salt or calcium chloride; in planning the routes, to avoid as much as possible of empty truck travel while covering important danger points; in preparing to treat by hand-spreading from boxes or piles the shorter areas, as intersections, short hills, railroad crossings, etc.; and by having some adequate system for determining when conditions are such that sanding operations should begin. The latter is not always easy, since when the temperature is very close to 32° F., ice will form on some streets or in some areas, but not in others.

SALVAGE

—*for taxpayers, a* "BONUS"; *for labor, a* "BREAK"

Brick pavements have an exclusive advantage of a broad economic nature. After long service, the brick units have high salvage value.

Salvaging and relaying old brick on their new base is rarely ever an emergency* matter from the traffic standpoint. And this flexibility as to *time* when the work may be done permits postponement from periods when labor is scarce to times when men need employment.

Thus, relaying does not compete with private employment in good times; it furnishes a backlog of needed hand-labor when labor must have employment.

In recent years the Works Progress Administration has utilized this work with splendid results. Salvage of 40-year brick has often run over 75%. Engineer Fred T. Williams reports 116% salvage at Sanford, Fla., where "on edge" brick were turned flatwise in the new pavement. WPA forces turned out a good job which should equal the service the 36-year brick had already rendered.

New or relaid, brick has the longest life and lowest upkeep. Safe. Pleasant to ride on. And the big salvage is a "bonus" to taxpayers and a "break" for labor. National Paving Brick Association, National Press Bldg., Washington, D. C.

**The Reason*: At any stage of service, brick resists damage from weather as well as traffic.

BRICK

LONGEST LIFE . . . LOWEST UPKEEP

GREATEST SALVAGE VALUE

When Planning Your Snow Removal Program

you will want the

FRINK SNO-PLOWS

catalog showing the complete line of "V" Type and One Way Type Sno-Plows for all makes of motor trucks and tractors.

For every snow condition.

A post card or letter will bring your copy by return mail.

CARL H. FRINK, Mfr.

CLAYTON 1000 ISLANDS **NEW YORK**

DAVENPORT BESLER CORPORATION
DAVENPORT, IOWA

FRINK SNO-PLOWS OF CANADA, Ltd.
TORONTO, ONTARIO, CANADA

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

The Digestion Tank

Laying a Submarine 60-inch C. I. Sewer

THREE lines of 60″ cast iron pipe each 865 ft. long were laid across the Mississippi between Minneapolis and St. Paul in 26 ft. of water as part of the Twin City sewerage system. Four 12 ft. lengths of pipe were connected by modified Thatcher joints on a barge; then a pontoon consisting of three 6′2″ diameter cylindrical tanks was fastened on top of the pipe section, provided with flood and vent valves. A collapsible pipe guide was fastened in the bell end extending 2′3″ beyond the bell to facilitate placing the leaded bell over the spigot of the section previously laid, the guide being collapsed and withdrawn after the joint had been finished by a diver. The end tanks were flooded and the pipe section sunk to position and adjusted to line and grade by divers; the pontoon was disconnected and raised; the lead joints calked with air hammers, crushed stone placed up to the spring line of the pipe, and precast concrete blocks 4 ft. long weighing 6,500 lb. each were placed on the pipe, then additional stone ballast.[S2]

Sewer Forms Carry Truck Roadway

IN BUILDING a double box culvert 29 ft. wide by 10 ft. 8 in. high at Port Richmond, N. Y., narrow right of way and unstable soil made trucking of forms, concrete, etc. difficult. So trucking was done on the roof of the culvert, supported by Blaw-Knox traveling steel forms. A plank roadway is supported on the vertical forms for a 30 ft. length of sewer; concreting is begun at the forward end and the plank roadway taken up as the concreting progresses backward. Concrete is brought from central mixing plant in 1-yard loads. Forms are pulled ahead by line from form to and around pulley anchored to invert ahead, then back to 20 hp tractor operating on top of the sewer.[S1]

Decomposition of Sewage Sludge Deposits

STUDIES of oxidation of sludge deposits on stream beds indicated that there is no correlation between rate of O.D. and amount of available dissolved oxygen in supernatant water, but oxidation processes proceed at their normal rates if there is any residual oxygen. Rate of O.D. increases as about the square root of the depth of sludge; oxygen does not diffuse deeper than about 1 cm., but gases from anaerobic action below disrupt the sludge deposit, bringing new sludge into contact with the water. Light has no effect except indirectly by increasing oxygen liberated by algae. Aerobic decomposition increases proportionately with temperature; 1.8 times as great in fresh as in highly saline water and practically in an inverse straight line ratio with salinity. Light and salinity do not affect the saturation population of bacteria in aerobic sludge, but temperature does. The longevity of B.Coli is much greater in sludge under salt water than under fresh. Protozoan content of sludge increased very rapidly under fresh water, but disappeared in 24 hrs. under salt, which may explain lower B.O.D. rates under saline conditions. "The short period of experiment . . . fails to establish many factors with finality and yield absolute results."[C61]

Oxidation of Activated Sludge

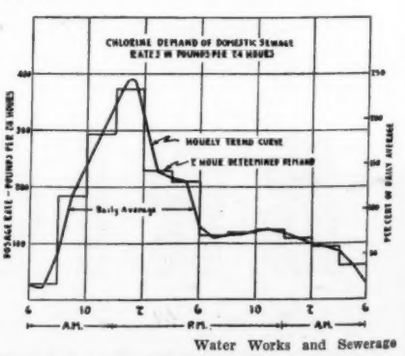
OXIDATION rates are obtained in activated sludge much greater than the normal biochemical oxidation in streams, due to the development of a mass of bacteria by the application of food and maintenance of proper aerobic conditions for their rapid propagation. Independent observations on the quantities of oxygen required by fed and unfed portions of an activated sludge gives information, obtained after a relatively short observation period, which enables a quick discovery of unsatisfactory conditions in the operation of a plant and correction of them before they become unmanageable. The quantity of oxygen used by the unfed or control sludge is a criterion of sludge condition. The quantity of oxygen used per gram of suspended solids by a good unfed return sludge seems to vary from about 10 to 30 mg. in 5 hours. Experience at any particular plant will indicate the optimum range of oxygen requirement of the sludge for the operation cycle at that plant.[C69]

Chlorine Demand of Sewage

STUDIES of chlorine demand of Buffalo, N. Y., sewage at the laboratory of the sewage authority has led to the following conclusions: The chlorine demand per capita for strictly domestic sewage is 0.00467 to 0.0050 lb. per day —a more important basis for calculation than ppm. Temperature has little effect on chlorine demand when between 12° and 24° C., but below this range the demand is only 65% to 74% as high. Average chlorine demand of relatively fresh domestic sewage is only 4 to 5 ppm.; of strong sewage, 8 to 11 ppm.; may be 30 ppm. for mixture of industrial waste and sewage. Chlorine demand during a day may vary from 30 to 560% of the average for the day; average range 50% to 190% for strong sewage, 35% to 145% for normal domestic. Ratio of chlorine demand to B.O.D. is entirely dependent on the quality and age of the sewage or the type of industrial wastes present. In the larger sewers, chlorine demand changed materially during 15 to 30 min. periods.[G31]

Driving Sewer Tunnels with Shields

Two circular sewers, one 6 ft., 750 ft. long, the other 4 ft., 1200 ft. long are just completed on Staten Island, New York, using shields, and interlocking trapezoidal blocks for lining. The larger shield was pushed forward by 24 4″ jacks, the smaller by 18 jacks, pressure supplied by oil in a closed circuit. Muck was loosened by pneumatic clay spades. The blocks are tongue-and-grooved on all edges, which are dipped in hot asphalt before setting, thus providing a cushion and water-tight joints; no pointing of joints is necessary. The blocks were made in hydraulic presses with 1:1.8:2.2 mix using ½ in. gravel; compressive strength over 2500 lb. in 7 days. Manholes were sunk to finished sewer and top blocks broken out from above.[E20]



Water Works and Sewerage

Step diagram and trend curve for sewage chlorine demand study

This outfall from the sewage disposal plant at Burlingame, California, is a striking example of the universal reliance on cast iron pipe as a corrosion-resistant material. Not only is the line cast iron but it is supported by U. S. Super-de Lavaud cast iron pipe acting as piles. Sanitation engineers also rely on cast iron pipe for great structural strength and permanently tight, infiltration-proof joints. U. S. Cast Iron Pipe, either pit-cast or Super-de Lavaud *chill-free* centrifugally cast, is quickly available anywhere. Stocks carried at 15 shipping points.

UNITED STATES PIPE AND FOUNDRY COMPANY

General Offices: BURLINGTON, NEW JERSEY

Foundries and Sales Offices throughout the United States

U. S. CAST IRON PIPE

for sewers and sewage treatment plants

Ypsilanti's New Treatment Plant

THIS is to provide for 15,000 population. Roof water entering the sanitary sewers greatly increases the flow during rains. Sewage is pumped to treatment plant, after passing through a comminutor, through 1600 ft. of transite pipe. Of the two 40 ft. radial flow clarifiers, one is a flocculator-clarifier; the other may be changed to this if it should act as expected—flocculate the solids so they will settle more readily and permit using a smaller tank.[H52]

Sludge Drying in Cleveland, Ohio

CLEVELAND'S southerly plant contains 9 glass-covered beds each 224′ 3″ by 17′ 9″ inside dimensions. Sludge is applied 11″ to 12″ deep and removed in about 24 to 28 days. Given to the public (large demand), the recipient loading it into 0.8 yd. dump cars, which operatives run onto bed on industrial track, using gasoline locomotive, then run filled cars to unloading platform, where recipients unload it to their trucks. Fine sand was used on the beds until 1934; since then, grit from Imhoff tank pockets and grit chambers. Moisture content of sludge reduced from 90% to 74% by drainage in about 2.5 days; final depth of cake 3.5″ to 4″. Loss of cinder grit nearly twice that of sand, it being harder to distinguish sludge from it than from sand when removing it; but cinders are decidedly economical. The losses are considerable since public do the removing. Drying time for 9.3″ was half that for 12.4″ with same average temperatures. There is thus a saving of time by using shallow sludge depth, but greater grit (or sand) losses.[C74]

Operating Geneva's Gulvin Park Plant

THIS plant treats 90% of the sewage of Geneva, N. Y., from 15,800 population, with beet canning wastes during 5 months of the year. Plant includes mechanically cleaned bar screen; 3 raw sewage pumps, 3 rectangular mechanically cleaned settling tanks, chlorinators, 2 heated digestion tanks with mechanical agitators, gas-fired boiler, glass-covered sludge drying beds with monorail sludge handling system. Operated since October 1935. During 1937 the average daily flow was 1,672 mg.; maximum 6,523 mg. (although separate sewer system). There were three employees: an operating chemist, 8 hrs. a day on operating; assistant operator, 4 hrs. operating, 4 hrs. maintaining; laborer, 2 hrs. operating, 6 hrs. maintaining. The electric power used for pumping, lighting and treatment averaged 5,740 kwh. per month. Screen cleaned every 10 min. during the day and 20 min. at night, removed 9.1 cu. ft. per mg. Sludge removed from sedimentation tanks, 938.1 cu. ft. per mg., collecting mechanism being operated for 2.5 hrs. twice daily. Scum removed by hand skimmer, approx. 0.75 cu. ft. per mg. Chlorine applied during 9 mos., av. 84 lb. per mg., residual av. 1.0 ppm. In digestion tanks, av. temperature of sludge 82.4°, pH 6.9; 50.5 cu. ft. of sludge per mg. removed to glass-covered beds, from which 32.9 cu. ft. of air-dried sludge is removed; av. drying time 31 days. Dry solids in sludges—primary 2.6%; digested 13.8%; air-dried 53.0%. Gas generated per day, from 11,784 cu. ft. to 22,382 cu. ft. with average CO_2 content of 31.1. Cost of treatment plant $153,204. Operating cost: Salaries and wages, $5.910; chemicals $1,425; power $1,349; misc. $1,187; int. on bonds $3,950; total $13,819; av. per mg. treated, $22.66; per cap. per yr. $0.875.[C79]

High Rate Trickling Filters

WITH heavy loading of trickling filters it is possible to obtain a high purification efficiency based upon pounds of B.O.D. per acre-foot per day, but at the expense of a good effluent, removing the most easily oxidizable substances but leaving the more stable although still putrescible ones. Effluents from the rapid-rate filters under discussion were unattractive in appearance, contained a high residual B.O.D. and but little nitrate.[C71]

German studies of high-rate filters indicated that stone of 5 to 7 cm. diameter (2″ to 2¾″) is most desirable, rather than smaller sizes, down to 0.5-1.5 cm. used in Russia. High rates on comparatively small areas give powerful flushing that removes the growth from the stones before it decomposes, it being discharged continuously, settling readily, being high in moisture, putrescible and of greater volume than that from a low-rate filter. Therefore the filter does not act also as a digestion tank. To insure continuous discharge of solids, the rate of 0.8 to 0.5 cu. meter per sq. meter per hour. Halvorsen recommends a minimum rate of 0.5 cu. meter continuously through preliminary tank and filter, but Pönninger (for stronger German sewage) resting 6 hrs. daily and one complete day a week.

These filters can be operated to a depth of 2.0-2.5 meters without artificial aeration, or 4 meters with. The stronger the sewage the deeper the filter, to obtain the proper surface rate; or this may be obtained by diluting with filter effluent or other water. The sludge is very putrescible and should be removed from the secondary tanks continuously.

It is essential that there be good contact with the air at the base, closed walls, uniform mechanical distribution, sufficiently high dosing rate to induce unloading, but the organic content of the applied sewage must not exceed the biological purifying capacity of the filter voids.[C72]

Requirements of Wisconsin and Minnesota State Boards of Health include: A controlled circulation system giving continuous dosing with sewage not exceeding 200 ppm. 5-day B.O.D., the loading not to exceed 1 lb. of B.O.D. per sq. ft. of filter per 24 hrs. based on an 8 ft. depth, or 26 mgd. per acre in any case. Primary settling with 2-hr. detention based on maximum 18 hr. flow. Filter media, crushed rock or gravel 2″ to 3″ diameter, or equivalent. Underdrainage system having a capacity 3 times the maximum flow, with a total unsubmerged inlet area of at least 5% of the filter surface at time of such flow. A secondary tank with 2-hr. detention at time of maximum flow. Uniform distribution. These do not apply for installations used after fine screens with undigested sludge disposal, which are still in the experimental stage.[C73]

Treating Packinghouse Waste at Muncie, Ind.

THE Kuehner Packing Co.'s plant is the only one in Indiana to give complete treatment to packinghouse waste. Major organic load is between 10 A. M. and 5 P. M., at times suspended solids and B.O.D. reaching 2,000 ppm. Long preaeration period smoothes out organic load, aided by dilution with waste condenser water and high rate of return sludge. When there is any indication of bulking sludge, air is applied to final clarifier for 10 min. at 2 hr. intervals to prevent discharging bulking sludge into the stream. Cost of treatment, 5.5 cts. per hog unit, less a considerable revenue from sale of grease skimmings. Effluent is satisfactory to State Board of Health and well within the standards of the Department.[C77]

Growth-Promoting Substances in Sewage

RESULTS from use of sewage and sludge as fertilizer can not all be accounted for by the mineral constituents—nitrogen, phosphorus, potash, etc., explained as due to increase in moisture-holding capacity or ventilation of the soil, number of decomposition bacteria or other micro-organisms. Studies of substances capable of inducing different growth responses and their presence in

sewage and sludge form the subject of a series of papers to be published by the New Jersey Agricultural Experiment Station. The groups are 1—complex organic matter; 2—amino compounds; 3—degradation products of complex organic materials such as indole, skatole, phenyl and naphthyl compounds; 4—gases and 5—some miscellaneous materials.[C67]

Indole and skatole stimulate rooting and other growth phenomena of plants. From 1.3 to 14.8 ppm. are found in fresh sewage solids; increasing in one case to 160 ppm. (dry solids basis) on standing 4 weeks—the increase chiefly in skatole. On the basis of these substances, raw sewage would have the greatest value, followed by settled and chemically treated sewage, with oxidized effluents the least. They tend to increase during anaerobic digestion but are utilized by methane organisms, so that ripe sludge contains less indole and skatole than fresh solids. Addition of dewatering chemicals fixes these substances, high heat destroys them but drying at ordinary temperature has little effect. Digested sludge dried at low temperature contains relatively large amounts of them and would have value as a base for complete fertilizers.[C68]

Bibliography of Sewerage Literature
The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

C *Sewage Works Journal*
July

67. *t.* Growth-Promoting Substances in Sewage and Sludge. By W. Rudolfs and B. Heinemann. Pp. 643-652.
68. *t.* Indole and Skatole in Sewage and Sludge. By W. Rudolfs and R. S. Ingals. Pp. 653-660.
69. *t.* Biochemical Oxidation by Activated Sludge. By C. C. Ruchhoft, P. D. McNamee and C. T. Butterfield. Pp. 661-690.
70. *t.* Carbon Dioxide Production in the Activated Sludge Process. By H. Wilson and J. A. McLachlan. Pp. 691-699.
71. Experimental High-Rate Trickling Filters. By G. P. Edwards and G. O. Adams. Pp. 700-704.
72. The Design of High-Rate Trickling Filters. By K. Imhoff. Pp. 705-711.
73. Tentative Standards of Wisconsin and Minnesota State Boards of Health for Plants Using High-Rate Filters. Pp. 711-713.
74. Sludge Drying on Glass-Covered Beds. By G. E. Flower, C. B. Budd and C. Hauck. Pp. 714-721.
75. Laboratory Analysis and Studies in Plant Operation. By E. Hurwitz. Pp. 722-730.
76. Hazards and Safety Measures at Sewage Works. By P. J. Houser. Pp. 731-737.
77. Disposal of Packinghouse Waste. By M. A. Milling and B. A. Poole. Pp. 738-746.
78. Natural Stream Purification as Applied to Practical Measures of Stream Pollution Control. By H. W. Streeter. Pp. 747-753.
79. Gulvin Park Sewage Treatment Plant; 1937 Operation. Pp. 756-769.
80. New Britain, Conn., Sewage Treatment Plant; Report for 1937-1938.
81. Operation Report, Springfield Sanitary District Sewage Treatment Works. Pp. 781-791.
82. Nitrification. By F. W. Mohlman. Pp. 792-793.

D *The Surveyor*
August 5

48. Sewage Disposal at East Barnet. Pp. 145-147.
49. Sewage Purification at Hyde. P. 153.
50. Glasgow Sewage Purification Works. Pp. 165-166.

E *Engineering News-Record*
August 4

20. *c.* Small Shields Drive Tunnels for Staten Island Sewers. Pp. 149-150.

August 11

21. A Picture of Pollution in the Hudson. By C. J. Velz. Pp. 181-183.

August 18

22. Cleaning Up the Great Lakes (Disposal Plants). By E. J. Cleary. Pp. 197-201.

G *Water Works & Sewerage*
August

29. *p.* Sewer Rental Method of Sewerage Financing. By R. A. Allton. Pp. 758-760.
30. *p.* Sewage Sludge Incineration. By E. T. Killam. Pp. 771-781.
31. Laboratory and Field Studies on Chlorine Demand of Sewage. By G. E. Symons, G. E. Terhoeven and W. L. Torrey. Pp. 789-795.
32. Iron Pickling Wastes in Sewage. By C. F. Hauck. P. 796.

H *Municipal Sanitation*
August

51. Waste Treatment in Industrial New England. By R. S. Weston. Pp. 384-387.
52. Flocculation, Clarification and Chlorination for Ypsilanti. By W. R. Drury. Pp. 388-389.
53. Maintenance of Sewage Screens. By L. M. Johnson. Pp. 390-394.

J *American City*
August

22. Sewer Cleaning Machines in New York City. By H. W. Levy. Pp. 51-52.

P *Public Works*
August

33. Building Princeton's Storm Water System. By J. R. Riker. Pp. 12-14.
34. Safety in Maintaining Sewers and Sewage Treatment Plants. By L. W. Van Kleeck. Pp. 20-22.
35. *p.* Financing Sewage Disposal by Charges for Sewerage Service. By C. W. Frank. Pp. 27-28.
36. Treating Sewage Containing Pickling Wastes. P. 29.

1. Clean the flange.

2. Measure the diameter.

3. Cut length of TAPAX needed.

TAKING THE **BANG** OUT OF MANHOLE COVERS with

TĀPAX

Quick - Easy - Lasting

TAPAX is the surest relief from rattling, banging manhole covers and offers you the simplest solution for noisy covers at a cost of comparatively a few cents an application. TAPAX is a resilient cushioned composition of asbestos and bronze, shipped in convenient reels. It will "stay put" for years. Ask for sample.

4. Form it with hands

5. Put TAPAX—sticky side down—on flange. Replace cover.

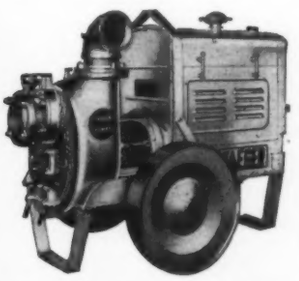
Let us send you a trial order reel

TROHN'S SUPPLIES Incorporated
201 HOYT AVENUE MAMARONECK, N. Y.

5200 Gallon Bantam Pump

$75.00 F.O.B. FACTORY COMPLETE WITH ENGINE

FASTEST PRIMING, BIGGEST CAPACITY LIGHT PUMP ON MARKET



JAEGER "SURE PRIME" PUMPS

Prime faster, pump full volume, pump more hours. Sizes 2", 3", 4", 6" 8" 10", capacities to 200,000 G.P.H. Send for catalog. The Jaeger Machine Co., 400 Dublin Ave., Columbus, O.

The **FORD** *Portable*
TESTING TANK
FOR TESTING WATER METERS

A positive, accurate and convenient tester for use in the meter shop or on the job. Absolutely simple and easy to use. Should be in every water works, large or small.

Write for catalog and further information.

THE FORD METER BOX CO.
WABASH, INDIANA, U. S. A.

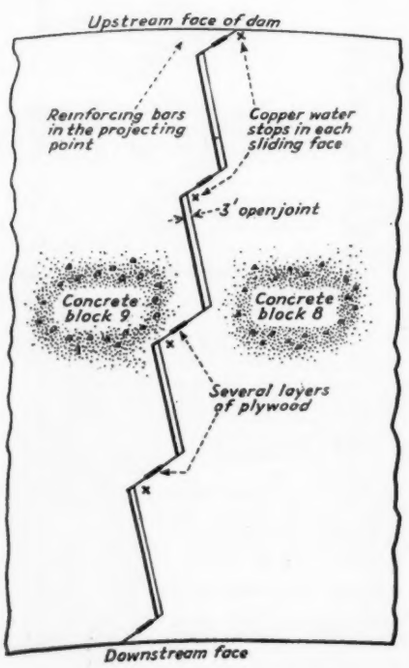
SETTING AND TESTING EQUIPMENT FOR WATER METERS

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

Chemical Cleaning of Iron Water Mains

AT Stockton Springs, Me., in May 1938, 575 ft. of 1" galvanized pipe was cleaned by the Hydro-Artgel chemical method, using an acid containing an inhibitor which prevents it from attacking any ferrous or cuprous metal. A 50 gal. surge tank was set up at each end, connected to the pipe with rubber hose, and with an air compressor midway between them. Enough chemical to fill the pipe was surged back and forth, but dislodged scale plugged it. This was finally blown out and surging continued for 4 hrs., when pipe was found to be thoroughly clean. Then a hydrated lime solution was surged back and forth then flushed out with clean water. Pipe interior was smooth and bright with faint markings where tubercles had been. Several services, plugged with scale, were blown out with air pressure. This test suggested passing chemical through pipe in one direction only until large part of scale has been removed; also blowing out services with compressed air in the cellar, before main is finally flushed. Cost of this job estimated at 10c a foot.[V6]


Upstream face of dam
Reinforcing bars in the projecting point
Copper water stops in each sliding face
3' open joint
Concrete block 9
Concrete block 8
Several layers of plywood
Downstream face

Engineering News-Record

Sliding type joint in Morris dam

Artificial Earthquake to Test Dam

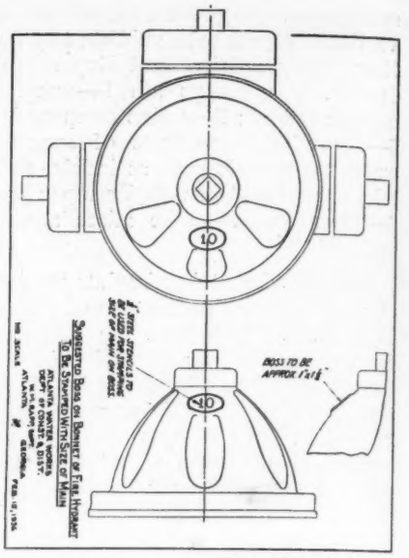
MORRIS Dam, Pasadena, Calif., concrete, gravity, about 800 ft. long, max. height 328 ft., max. width 280 ft. was built with a vertical joint near midlength over an old fault in the foundation, so that any future movement at the fault would not damage the structure seriously. It had been computed that the period of vibration of the structure was about 0.14 sec. As a part of seismic investigations of the U. S. Coast and Geodetic Survey, a powerful shaking machine with motor-driven eccentric flywheels was used to simulate earthquake vibrations, check on the vibration period, learn whether the two parts of the dam (separated by the joint) act together and study other features. Among the determinations: The natural vibration period of the dam is 0.17 sec.; vibrations crossed the joint in the dam, even increasing in crossing (agreeing with observations during real earthquakes); the amplitude of vibration was proportional to the vibrating force.[E37]

Marking Hydrants for Main Size

To inform firemen of the size of main to which any fire hydrant is connected, W. M. Rapp has devised the following: A boss is cast on the cap of the hydrant near the operating nut and on this the size of main is stamped with a ½ inch hand cut steel die when the hydrant is set. For stamping old hydrants, first file a uniform flat surface on the cap.[G30]

Economics of Water Treatment

THE authors analyzed the economic value of each of the characteristics of pure water, and the cost of treatment to secure such characteristic. They estimate that removal of danger from typhoid is worth $20,000 per death, or $80 per mg. of water furnished; cost of filtration by slow sand filters, $1.00 to $6.65; by rapid sand, including pumping, $2.79 to $16.78. Value of removal of color, 55c per mg., per ppm. over 10 ppm.; cost of removal, 10c to $2.38. Removal of turbidity, value per ppm. over 5 ppm., per mg., $1.10; cost, 7c to $4.38. Removal of hardness value



Water Works & Sewerage

Indicating size of main on hydrant

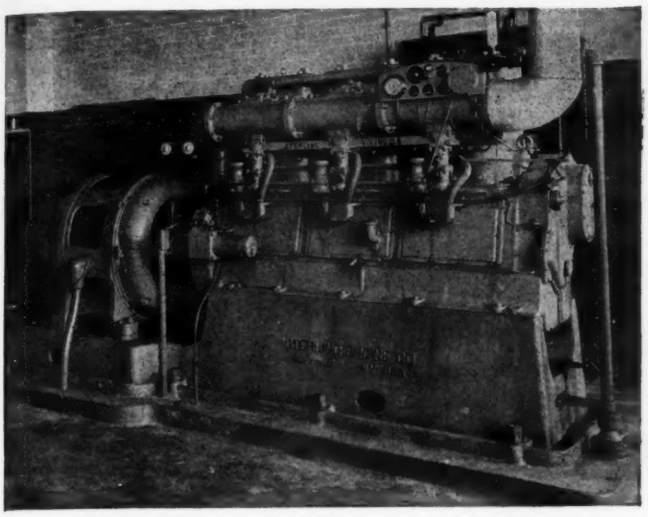
per ppm. over 100 ppm., per mg., 41c; cost, 8 to 33c. The values are estimated. The costs are those actually determined in more than a score of plants. High costs are due to small amounts of color and turbidity to be removed—perhaps not justified from an economic point of view.[B25]

Financing Main Extensions

HARTFORD, Conn. has used four methods of financing extensions of its distribution system: (1) From water revenue. (2) Guarantee method, those asking for the extension guaranteeing an income of 10% of its cost. (3) Assessing against abutting property at a rate per foot equaling the average cost of 8" pipe during the previous five years, including in the charge the cost of street intersections and exempted property. (4) The "supply main" method, substituting for assessment a connection charge when the connection is made. No. 1 would greatly increase water rates. No. 2 did not proportion payment over all the property supplied nor insure continuity of payment. No. 3 has produced the most satisfactory results. No. 4 insures 100% collection of assessment and elimination of losses through foreclosure for non-payment of taxes.[B27]

Hardness Determination by the Soap Solution Method

The laboratory methods available for determining total hardness are the gravimetric (making a complete mineral analysis); "Standard Methods" soap solution; Hehner (using sulphuric acid for temporary and sodium carbonate for permanent hardness); Pfeifer & Wartha (using sodium hydroxide for precipitating magnesium and sodium carbonate for calcium); Blacher



Sterling

THE ENGINE OF REFINEMENT

SHUSHAN (NEW ORLEANS) AIRPORT employs 200 K.W. Emergency Generator Set driven by Sterling Viking 6-cylinder 425 H.P., 1200 R.P.M. Engine, direct connected to 200 K.W. General Electric Generator for standby.

STANDBY POWER

Quick starting engines are needed to supply emergency power when storms or mechanical failures interrupt utility current. Many Sterling Engines serve faithfully and immediately, providing electricity so quickly that the outage is scarcely noticeable. The data compiled as a result of these installations is available on request.

STERLING ENGINE COMPANY

Home Office and Plant
1270 NIAGARA STREET
BUFFALO, N. Y.

DEPT. C-5

Branch Office
900 CHRYSLER BLDG.
NEW YORK, N. Y.

The LOCK JOINT "Book of Experience"

Through a Florida Cypress Swamp

Through a Florida Cypress Swamp

AT ST. PETERSBURG, FLA., Charleston, S. C., and Denver, Colo., adaptability to wet laying conditions meant positive savings in pipe line cost.

The joints of Lock Joint Pipe permit quick and effective sealing after laying, even in a very wet trench, thereby minimizing costly sheeting and dewatering. Furthermore, these tight, permanent, and flexible joints guarantee a pipe line free of troublesome leaks.

The use of Lock Joint Reinforced Concrete Pressure Pipe for your next pipe line will insure economy in installation and minimum maintenance costs.

LOCK JOINT
Reinforced Concrete
PRESSURE PIPE

LOCK JOINT PIPE CO. Est. 1905. Ampere, N. J.
Pressure : Sewer : Culvert : Subaqueous

When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 71-73

(precipitation with potassium palmitate); alkaline phosphate; and the potentiometric — a relatively untried method. Each has certain advantages, none is entirely satisfactory. Prime requirements are speed, simplicity, accuracy and adaptability to the control of lime-soda softening plants. Two sets of investigators, in Stockton, Calif., and Tucson, Ariz., believing the soap solution the most promising, have developed laboratory methods which they describe in detail. The former "is remarkably accurate over a wide range of calcium and total hardness values"[A108]; the latter "can be successfully employed for the rapid and accurate determination of calcium and magnesium."[A109]

Houston, Tex.
Wells and Ground Water

The city supply of Houston is from wells, practically all gravel wall type, the entire casing below the pump pit surrounded by a gravel wall about 8" thick. The specific capacities of the wells (gallons per minute per foot water level is lowered) vary from 15.6 for a well drilled in 1917; 23 for those drilled between 1925 and 1930, to 30 for those drilled subsequent to 1930. This may be due to progressive clogging of screens or improved well construction. The average cost of drilling and equipping a well, including pumping station, has been about $50,000. Ground water levels are falling rapidly. Early in 1936 the static water level was everywhere less than 20 ft. below sea level; by Nov. 1937 it was more than 20 ft. in over 50% of the city's area, with a maximum of 70 ft. near the point of heaviest pumpage. It is recommended that a surface supply be developed, as supplementary to the wells.[A111]

Sterilizing a Well
With Chlorine and Dry Ice

A well 250 ft. deep, 4½" diam., at Tonica, Ill., gave reduced yield in 1937. The static head was not lower. As much organic sludge composed of a gelatinous matrix and protozoa was pumped, reduction was considered due to organic growth in the sand around the well. To kill this, the pump was removed and ¼ of a can of calcium hypochlorite dissolved in a bucket of water was dumped into the well. Sixteen 3 lb. sticks of dry ice had been obtained, and one was dropped in after the chlorine, which stirred the water. After 15 minutes a similar dose of chlorine and 3 sticks of dry ice were placed in the well; then more chlorine and 6 sticks, which gave a gas evolution of nearly explosive character. After 30 minutes the rest of the chlorine was used, with three 2-stick charges of dry ice at 5 minute intervals, the top of the well being plugged. The gas evolution forced the gas into the ground and loosened the organic growth. The pump, replaced, brought up water full of black sludge. The yield was restored and has remained so. There is no danger of freezing the water if there is 11 lb. of water to one of dry ice[A115]

Activated
Carbon Tests

Of the two methods available for measuring the odor-removing capacity of activated carbon, the phenol test is of secondary importance to the threshold odor test. In many cases the odors are not caused by phenolic compounds and respond to carbon absorption in a manner markedly different from that of phenol. The long contact period of the test is much greater than that in practical use. The 0.10 ppm phenol concentration of the test solution has a much lower odor intensity than those encountered in practice. Phenol value and odor removal capacity are expressed in units which are mutually nonconvertible, the ratio between them differing for different carbons and different waters. On the other hand, the threshold odor test provides a method of evaluating carbons directly on the water to

NORIT

We invite you to try NORIT activated carbon in your plant. Our technical staff is at your Service.

for information write
L. A. SALOMON & BRO.
SELLING AGENTS
216 Pearl Street New York
American Norit Co., Jacksonville, Fla.

INQUIRIES INVITED on all Problems of Water Treatment

We serve as skilled contractors to furnish and install the complete hydraulic and mechanical equipment in all forms of water treatment plants.

ROBERTS FILTER MFG. CO.
640 COLUMBIA AVE. DARBY, PA.

Assurance

You know a Friez instrument is the best—that each instrument has behind it sixty years of constant effort to assure the performance you expect of it.

STANDARD RAIN GAGES
WATER LEVEL RECORDERS

FRIEZ BALTIMORE

Instruments for Recording all Conditions of Air and Weather
JULIEN P. FRIEZ & SONS, INC.
BELFORT LABORATORIES BALTIMORE, MD.

be treated and can be relied upon for accurate results. There is need, however, for a satisfactory test which can be used as a convenient basis for purchase and manufacture of carbons.[A117]

The Board of Directors of the A. W. W. A. has adopted tentative specifications embodying both the phenol and threshold odor tests. Changes are probable because the use of activated carbon is still being developed. Many odors are so strong that producing odorless water with present procedures is impracticable though possible. Only a small fraction of the odor-reducing capacity is now being utilized; there should be better methods of getting carbon in contact with the water. Both carbon manufacture and art of use should be improved.[A118]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n*
July

108. *t.* Improvements in the Soap Solution Method for Determining Hardness of Water. By K. W. Brown and P. A. Villarruz. Pp. 1021-1039.
109. *t.* Determination of Calcium and Magnesium by Soap Titration. By E. L. Breazeale and R. A. Green. Pp. 1040-1048.
110. Some Problems Relating to Legal Control of Use of Ground Waters. By D. G. Thompson and A. G. Fiedler. Pp. 1049-1091.
111. Well Water Problems of Houston. By L. R. Howson. Pp. 1092-1102.
112. High Lights of the Water Supply System of New Orleans. By A. F. Theard. Pp. 1103-1115.
113. Water Supply System of Mexico City. By E. Molina. Pp. 1116-1123.
114. Water Supply System of Vera Cruz. By D. G. Alarcon. Pp. 1124-1129.
115. Sterilization and Cleaning of a Well with Chlorine and Dry Ice. By M. Suter. Pp. 1130-1132.
116. Specifications and Tests for Powdered Activated Carbon. Committee Report. Pp. 1133-1224.
117. Comparison of Tests for Activated Carbons. By W. A. Helbig. Pp. 1225-1233.
118. Specifications and Tests for Powdered Carbons. By L. C. Billings. Pp. 1234-1237.

B *Journal, New England Water Works Ass'n*
June

25. Economics of Water Purification. By A. L. Shaw and E. S. Chase. Pp. 131-150.
26. Need for Improvements in Distribution System of Boston Metropolitan Water District. By. E. C. Hultman. Pp. 151-177.
27. Financing Main Pipe Extensions in Hartford, Conn., Distribution System. By W. A. Gentner. Pp. 178-189.
28. New Sand Wash Brook Dam and Reservoir at Pittsfield, Mass. By S. M. Ellsworth. Pp. 190-200.
29. Experiences with Reinforced Concrete Standpipes. By C. W. Sherman. Pp. 201-213.
30. *t.* Economics of Pumping Equipment. By D. D. Eames. Pp. 214-224.
31. Diesel Pumping Plant at Milford, Mass. By M. H. Goff. Pp. 225-227.
32. *t.* Principles of Corrosion and Its Prevention. By Frank N. Speller. Pp. 228-232.
33. *t.* Cathodic Protection. By A. V. Smith. Pp. 233-243.
34. Enforcing Payment of Water Bills. By D. M. Sullivan. Pp. 244-247.
35. New Development in Fluid Meters That May Affect Water Meter Design. By W. Parker. Pp. 248-253.
36. Rubber and Like Substances in Waterworks Practice. By E. A. Hauser. Pp. 254-255.

E *Engineering News-Record*
August 11

36. Reliable Water Service (Madison, Wis.). By W. W. De Berard. Pp. 169-172.
37. Dam Tested by Artificial Earthquakes. Pp. 184-185.

F *Water Works Engineering*
August 3

51. Repair Shop and Maintenance Methods at Springfield, Mass. By N. N. Wolpert. Pp. 1026-1030.
52. Coagulation of Denver Mountain Water Aided by Sodium Silicate. By O. J. Ripple. Pp. 1038-1039, 1050.

August 17

53. Operating Results at Norwood Iron Removal Plant. By J. W. Greenleaf, Jr., and B. F. Snow. Pp. 1080-1082.
54. *p.* Importance of Ground Water Supply. By O. E. Meinzer. Pp. 1086-1088.
55. Dry Feed Scattering of Chemicals in Treatment of Reservoirs. By R. F. Goudey. P. 1112.

G *Water Works & Sewerage*
August

28. *p.* Water Main Cleaning. By T. B. Ray. Pp. 753-757.
29. *p.* Glances at Recent Water Treatment Practice. By L. L. Hedgepeth. Pp. 771-772.
30. Marking Fire Hydrants Neatly and Pernanently. By W. M. Rapp. P. 772.
31. *p.* Cathodic Protection. By S. Thayer. Pp. 783-785.
32. *p.* Activated Carbon Application Efficiency. By M. C. Smith. Pp. 786-787.
33*p.* Disapproved Plumbing Fixtures. By A. B. Cronkright. Pp. 801-803.

P *Public Works*
August

36. Building Concrete Reservoirs Without Expansion Joints. By P. D. Cook. Pp. 15-16.
37. Meters and Meter Specifications. Pp. 25-26.
38. Bases for Rating Illinois Swimming Pools. P. 26.

T *Technique Sanitaire*
June

4. Le Fer et Le Manganese Dans Les Eaux. By F. Dienert. Pp. 105-116.

V *Journal, Maine Water Utilities Ass'n*
August

6. Experiences with Water Main Cleaning. By T. B. Ray. Pp. 89-99.

W *Johnson Nat'l Drillers Journal*
July-August

4. Conservation by Water Spreading. Pp. 1-5.
5. Testing Wells for Yield and Drawdown. Pp. 10-13.

Liability for Sewage Overflow

In an action for damages resulting from an overflow of sewage onto residence property from a sanitary sewer owned by the defendant city, the Iowa Supreme Court (Wilkinson v. City of Indianola, 278 N. W. 326) affirmed a judgment for plaintiff, holding that the jury could have found that the sewer was constructed and fit solely for sewage disposal, and unintended and inadequate for storm sewer purposes; that nevertheless intakes were opened to drain surface waters from heavy rainfalls through this sewer; that the result was such an overcharging of the sewer that several overflowings from the manhole occurred, with damage to plaintiff's premises, of which the city knew. The court found no evidence to support a defense that at the time of the overflows a contractor was installing paving for the State Highway Commission and not for the city, and if there was negligence it was that of the contractor.

Bursting of Water Main

In an action against a city for damage to goods by the bursting of a water main at a street intersection, resulting in the flooding of a basement, the only question was whether the defendant had been negligent. The main was a twelve-inch "high-service" pipe, laid in 1896. The cause of the break was unknown. No negligance in laying the pipe or maintaining it appeared. A slight seepage in an adjoining basement had been noticed and reported to the city's water department, which had remedied it. This seepage might have come from a variety of sources, some of which might not have been in the control of the city. The Massachusetts Supreme Court (Gerard v. City of Boston, 13 N. E. 2nd. 415) held that due care did not require the city to expose and examine all the pipes at the street intersection, and that there was no evidence of negligence. Verdict for the city was held properly ordered.

Liability Under Sewer Construction Contract

The Wisconsin Supreme Court holds (Wenzel & Henoch Const. Co. v. Town of Wauwatosa, 277 N. W. 624, an action by a construction company to impose direct and general liability on the defendant town for the construction of a sanitary sewer and furnishing of material therefore pursuant to contract between the parties) that a contract under which the city agreed to assess the property benefited by the construction and pay the money collected to the construction company, and an agreement extending the time for completion of the construction and also extending, for a year, the time for payment to the contractor, so that assessments would become due in the March following completion of the work in June, did not impose direct liability on the city. The city was only required to pay the contractor from money collected from the assessed property owners.

Although the town could have proceeded under statutes by which special improvement bonds or certificates could have been issued and given to the contractor in payment of the contract price it was held not required to do so.

The Operation of Sewage Treatment Plants

TABLE OF CONTENTS

Units and Methods of Measurement 39

The Composition of Sewage 39
Total solids—suspended solids—Bio-chemical oxygen demand—pH.

Tests and How to Make Them 40
Laboratory equipment needed—collecting samples—settleable solids—total solids—pH—residual chlorine—Methylene blue or putrescibility—BOD—DO.

Grit Chambers and Screens 42
Removing grit—types of grit removal devices—operation—records; types of screens—operation—disposal of screenings—records of operation.

Sedimentation Tanks 43
Purpose of sedimentation—results—types of tanks—operation data—records.

Sludge Digestion 46
Moisture content of sludge—amount of sludge—digesters—operation details—operating difficulties—utilizing gas—supernatant liquor—operating records.

Imhoff Tanks 49
Construction — general operation — sedimentation compartment — gas vents — scum — sludge compartment—drawing sludge—foaming and its cure—operation records.

Disposal of Sludge 50
The problem—sludge beds—depth of drawing—care of beds—removing sludge—disposal of sludge—winter operation—dewatering sludge—records.

Trickling Filters 54
Types of filters—methods of application—care of nozzles and orifices—dosing tank operation—pooling and ponding—filter flies—underdrains—winter operation—odors and prevention—records—secondary settling—filter loading.

Contact Beds and Sand Filters 56
Construction—operation factors—winter operation—records.

Chemical Treatment and Coagulation 58
How chemicals work—Ferrisul—aluminum sulphate—the iron salts—applying chemicals—mixing—dosages—procedure—laboratory tests.

Disinfection of Sewage 62
Purposes and uses—bacterial reduction—odor control—BOD reduction—coagulation—applying chlorine—operation of chlorinator—use of bleaching powder—computing dosages—records.

Vacuum Filters and Centrifuges 63

Preaeration 64

Fundamentals of Sewage Plant Operation

During the past decade there has been a remarkable development in the field of sewage treatment. Plants are becoming more highly mechanized, because mechanical equipment performs some services impossible by hand, gives more uniformly dependable results, and is more economical. There is increasing stress on the control of operation by laboratory tests and better knowledge of how to use them. The use of newer methods of treatment, as chemical coagulation and activated sludge, have made operation a really technical job.

Because of these developments, the old type of operator is disappearing; the man in charge of a sewage treatment plant today must be a trained man, though not necessarily an engineer or a chemist, except in the larger plants. Any one who is willing to learn through study, observation and attendance at short schools and conventions can become a trained operator.

Since Francis E. Daniels wrote for PUBLIC WORKS his book on Operation of Sewage Plants some 25 years ago, there has been available to operators no up-to-date concise, comprehensive and readily understandable text covering the entire subject. Within the limits possible, it has been attempted to supply this need in this issue. One or two omissions (as the section on Activated Sludge Operation) are under preparation and will appear in an early issue.

As in the case of a somewhat similar text on "Operation of Water Treatment Plants" (published in the April, 1938, issue), this material is intended to provide a foundation for the average operator, on which he may build further by his own efforts and in cooperation with his State Department of Health.

For their valued help and advice in preparing this text, the publishers of PUBLIC WORKS are indebted to those men whose names are listed below, and also to numerous others who contributed suggestions and material. A mimeographed preview copy of some 70 pages was sent to each of them and the hundreds of resulting suggestions have been used by us in giving the text its completed form as published in this issue.

F. E. DANIELS
W. B. MARSHALL
G. E. GRIFFIN
JOHN W. HOOD
ELLIS PHELPS
J. J. MCCARTHY
D. M. VAIL
R. N. CLARK
CHAS. H. EASTWOOD
M. C. FLEMING
J. K. HOSKINS
W. J. SCOTT
M. F. KOBLISH
FRANK ROE
W. A. DARBY
B. A. POOLE
S. L. TOLMAN
M. B. TARK
T. C. SCHAETZLE
S. I. ZACK
V. M. EHLERS
R. E. TARBETT
FLOYD G. BROWNE
L. L. LANGFORD

The Operation of Sewage Treatment Plants

Prepared by W. A. Hardenbergh and Consulting Staff

Units and Methods of Measurement

TEMPERATURE.—There are two common methods of measuring temperatures, Fahrenheit, abbreviated F, and Centigrade, abbreviated C. The former is most commonly used in the United States for everyday work; the latter is used almost exclusively in scientific work. The operator should be able to use each in terms of the other. In the F scale, freezing of water is at 32°, and boiling is at 212°, a difference of 180° between freezing and boiling. In the C scale, freezing is at 0° and boiling at 100°, a difference of 100° between freezing and boiling.

To change an F reading to a C reading, subtract 32 from the F reading, divide the remainder by 9 and multiply by 5. Thus to find what 104° F is on the C scale, subtract 32, leaving 72; divide this by 9, which gives 8; multiply this by 5, which gives the answer, 40° C. To change a C reading to F, divide by 5, multiply by 9 and add 32. Thus, to find the F value of 30° C: Divide by 5, which gives 6; multiply by 9, which gives 54; add 32, which gives 86° F, the answer.

The Metric System.—In laboratory work, and in most other scientific work, the metric system is used. This is simple, and easily learned. The basic unit of volume is the liter, which is slightly more than 1 quart (actually 1.05 quarts). This is equal to 100 cubic centimeters, and also to 1000 milliliters, the cubic centimeter being equivalent for all practical purposes to the milliliter. The unit of weight is the gram, which is the weight of 1 cubic centimeter of water under standard conditions. The milligram is one-thousandth of a gram, that is 1000 milligrams equal 1 gram. Therefore 1 liter weighs 1000 grams or 1,000,000 milligrams. The weight of a gram is about one-thirtieth of an ounce; a kilogram, which is 1000 grams, weighs about 2.2 pounds.

It usually does not work well to try to convert metric weights or volumes into pounds, ounces, inches, feet, quarts, etc. Whatever method is to be employed should be used throughout. The operator should become accustomed to use the metric system in all of his laboratory work, as it is much handier and is that used in most literature on the subject.

The following abbreviations are commonly employed: Liter, *l;* cubic centimeter, *cc;* milliliter, *ml;* milligram, *mg;* gram, *g;* kilogram, *kg.*

Most or all laboratory apparatus is graduated to cc or ml; and laboratory balances weigh in grams and milligrams.

Measurements. — The amount of solid matter in sewage, or the dosage of chemicals, such as chlorine, is preferably expressed in parts per million, abbreviated *ppm.* In the metric system, 1 mg to a liter is equivalent to 1 ppm; 3 mg per liter is 3 ppm. In the common system of measurement, 1 pound in a million pounds is 1 ppm. A gallon of water weighs 8.33 pounds; a million gallons weigh 8,330,000 pounds. A dosage of 1 ppm of, say chlorine, is 8.33 pounds per million gallons. Stated in the reverse order 8.33 pounds per million gallons is 1 ppm; 16.66 pounds per million gallons are 2 ppm.

A third way of stating dosages, not much used in sewage work, but quite largely in water purification, is grains per gallon, or *gpg.* 1 grain per gallon equals about 142 pounds per million gallons, or 142 ÷ 8.33 = 17.1 parts per million.

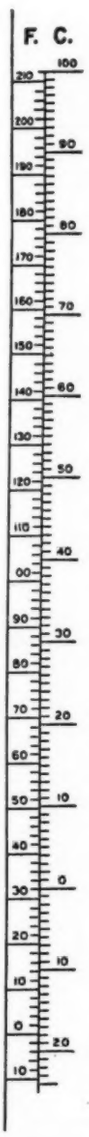


Fig. 1. At the left is a scale by which Fahrenheit and equivalent Centigrade temperatures may be read directly (see first two paragraphs at left

Fig. 2. Below is an Imhoff Cone, essential in making tests for settleable solids

Hydraulic Terms and Relations.—The flow of sewage is usually stated as so many gallons per day, abbreviated *gpd;* or occasionally as gallons per minute, *gpm.* When very large flows are concerned the term cubic feet per second may be used, abbreviated *cfs;* or millions of gallons per day, *mgd.*

Relations Between Terms.—A flow of 1 gallon per minute equals 60 gallons an hour or 1,440 *gpd;* 100 gpm equals 144,000 gpd; 500 gpm equals 720,000 gpd. There are 7.48 gallons in 1 cubic feet; therefore 1 cfs equals 7.48 gallons per second, or nearly 450 gpm., or 646,200 gpd, or 0.646 mgd.

The Composition of Sewage

Sewage as it flows in the sewers and before it arrives at the treatment plant is called *raw* sewage. After passage through the plant it is *treated sewage* or *effluent.* A part of a report on the analysis of a raw sewage may read something like this:

Total Solids	329 ppm
Organic Solids	197 ppm
Inorganic Solids	132 ppm
Suspended Solids	110 ppm
B. O. D. (5-day)	296 ppm
pH	7.0

What do these mean in terms of what the operator ought to know in order to run his plant efficiently?

Total Solids.—This means just what it says; the total solids in the sewage sample are 329 parts per million, that is, in a million pounds of sewage there are 329 pounds of solids. And these solids may be classified further, for some of them will be grit and sand, and others will be feces, bits of vegetables, etc.

The grit and sand (also carbonates, sulphates, etc.) are called fixed or inorganic solids. These are not so very much to worry about, for they will not decompose; while sometimes difficult to handle, and often a source of odor because of the organic material mixed with them, they are not what causes the operators' real troubles. The feces, vegetable particles and other elements of a similar nature are the organic solids and treatment of them is what gives the operator his job, and also most of his troubles.

This particular analysis was picked

COPYRIGHT 1938 BY PUBLIC WORKS JOURNAL CORPORATION

from a real plant. It showed that the sewage contained 329 ppm. total solids, of which 132 ppm. were inorganic and 197 ppm. were organic. Considering the latter, this means that in 100 gallons of sewage there are only about 2½ ounces of organic matter—a very small amount, but sufficient, nevertheless, to cause the sewage to decompose with odor.

Suspended Solids. — Some of the solids in sewage are dissolved as sugar is dissolved in coffee, but some are suspended in the form of particles of various sizes, and these suspended solids are both organic and inorganic. If the sewage is held quiescent in a tank or basin, some of the suspended solids will settle to the bottom. Usually not over half of them will be removed by plain sedimentation. In the sample we are considering, the suspended solids amounted to 110 ppm., and about 45% were removed by sedimentation, since an analysis of the effluent from the sedimentation tank showed 60 ppm. of suspended solids.

The solids that will settle are called settleable solids. The test for settleable solids consists of allowing the sewage to settle for 1 or 2 hours in special glass jars (Fig. 2). The results obtained by this test are not the same as is obtained in actual plant operation; but the test gives an idea of the amount of material that may be removed by settling.

It is not practical to remove all the solids from sewage. In most sewage treatment plants, the total solids are not greatly reduced—perhaps only 25%—but the organic solids must be changed over to remove so far as is possible their troublemaking characteristics. Thus the sewage treatment plant is designed to: (1) Remove suspended solids, both organic and inorganic, so far as possible; (2) convert organic matter into stable forms.

B. O. D.—These three letters are a simple way of writing the rather awesome term "Biochemical Oxygen Demand." The BOD of a sewage is the amount of oxygen necessary to stabilize the unstable and decomposable organic matter present.

The BOD of the sample considered at the beginning of this article was 296. This means that 296 ppm. of oxygen are necessary for satisfying the demand of the organic matter present during a stated period (5 days in this case). Remembering that 1 ppm. = 8.33 pounds per million gallons, 296 x 8.33 or about 2467 pounds of oxygen must be supplied to each million gallons of the sewage by means of the treatment devices to satisfy the BOD of 296.

In fact it will take more than this—about one-third more. To accomplish complete stabilization, several months are required. This is too long a period over which to run tests; and results three or four months after the sample is taken are not of much value in guiding operation. Therefore, in testing work, the results at the end of 5 days are usually taken. The BOD of 296 is the standard 5-day BOD result. Experience has shown that the 5-day BOD is about 68% of the final BOD requirement. The total biochemical oxygen demand therefore is about 3300 pounds per million gallons of sewage. This is supplied by such treatment equipment as trickling filters, and also by the dissolved oxygen that is present in the stream into which the sewage is discharged.

In the same sewage which has been discussed, the 5-day BOD of the settling tank effluent was 148; and of the trickling filters 43. The effect on the stream of the discharge of the raw sewage (BOD 296), of the settling tank effluent (BOD 148) and trickling filter effluent (43) can be computed. It may be easier to compute how much water, with 5 ppm of dissolved oxygen would be necessary to provide the necessary oxygen to supply the requirements, as shown by the 5-day tests.

With the raw sewage, there would be required 296 ÷ 5, or nearly 60 times as much water as sewage; for the tank effluent, 148 ÷ 5, or nearly 30 times as much water as sewage; and for the trickling filter effiuent, 43 ÷ 5, or about 9 times as much water as sewage.

pH.—This is a measure of the intensity of the acidity or alkalinity of the sewage, and is important in several ways. In these treatment plants where sedimentation and neither chemical coagulation nor the activated sludge method of treatment is used, the pH is mainly of value in guiding the operator in the treatment of sludge. Best digestion is usually obtained when the sludge is slightly alkaline; but some plants report good digestion with pH of 6.8 or even lower.

When chemical coagulation is employed, a knowledge of the pH value of the sewage is necessary to get most satisfactory results with the chemicals employed; and in activated sludge treatment plants in order to secure satisfactory results in operation.

A pH value lower than 7.0 shows acidity; and greater than 7.0 alkalinity. The lower the value, below 7.0, the greater or more intense the acidity; and the higher the value above 7.0, the more intense the alkalinity.

Other Tests. There are many other tests of greater or less value to the operator. Among those of value are the putrescibility of methylene blue test, used principally in the smaller plants and the residual chlorine test. These, along with the tests already mentioned in this chapter will be described (with one or two exceptions) in succeeding paragraphs.

In addition, there is the DO, or dissolved oxygen test which shows the dissolved oxygen content of the sewage or of the water into which it is discharged. In the sewage sample we have been using in this article, the DO of the raw sewage was 1.25 ppm. and of the trickling filter effluent 7.4 ppm. Other tests sometimes used include those for: free ammonia, which is a measure of the decomposition that has already taken place; the organic nitrogen; the total nitrogen; the nitrogen as nitrites and as nitrates; and the oxygen consumed. These tests usually are not as important to the operator as these previously mentioned.

There is evidence that the alkalinity of sewage may affect coagulation in chemical treatment; and the amount of free CO_2 may affect algae growths in the stream receiving the plant effluent.

Tests and How to Make Them

Some laboratory control of a sewage treatment plant is necessary. Certain tests, few in number and not difficult to make, even for the man unaccustomed to this type of work, are of much value in indicating results of operation and also in controlling the operation of a plant. These tests are those for:

a. Total solids
b. Settleable solids
c. pH (hydrogen ion concentration)
d. Residual chlorine
e. Putrescibility (for the plant which does not run BOD tests)
f. Biochemical oxygen demand
g. Dissolved oxygen

All but those marked *a, d* and *e* have been explained already in a general manner. Residual chlorine measures the amount of chlorine remaining in the sewage after a brief contact period. The putrescibility, or methylene blue, test measures the tendency of the sewage to decompose or putrefy, roughly paralleling the BOD test. The total solids test measures the amount of dissolved and suspended solid matter in the sewage. Of the seven tests, all but the last two are extremely simple.

Laboratory Equipment.—A copy of Standard Methods of Water and Sewage Analyses, published jointly by the American Public Health Association and the American Water Works Association, is a practical necessity. It gives precise and detailed directions for procedure in making all of the necessary tests. "Analysis of Water and Sewage," by Theroux, Eldridge & Mallman is an easier guide for men untrained in laboratory work.

A certain amount of laboratory equipment is needed. The amount depends upon the tests that it is desired to make. Your State Department of Health will work with you on this and will suggest what articles are needed. A small room or space should be provided for making tests.

Collecting Samples. — Samples may be "catch," that is a single pail or bottle full; or "composite" which are the combination of hourly or half-hourly samples taken proportionately to the sewage flow over a 24-hour period. Catch samples are usually employed in sewage plant tests for control and guidance in operation. DO and pH tests must be made with fresh catch samples.

In taking samples to show the results of treatment, allowance should be made for the time required for the sewage to pass through the plant. If the detention period in a settling tank is 2½ hours, and the sample of raw sewage at the influent is taken at 9 AM, the sample of the effluent should be taken at 11:30 A.M.; and if 30 minutes are required to pass through the trickling filter, a sample of this should be taken at 12 o'clock.

(Scott of Connecticut states he has found 1 hour to be a reasonable period for passage through sedimentation tanks, as actual detentions are invariably shorter than the theoretical ones.)

Try to take samples that are representative. Look the situation over and use your judgment. Exclude large solid pieces. A 2-qt. enamel dipper or a small pail, or both, are suitable for collecting samples. Arrange to make tests promptly. More information on this will be given in connection with testing, but in general, tests should be made within 2 or 3 hours. See *Standard Methods*.

Settleable Solids.—This test measures the amount of material that will settle out of the sewage; 2 hours is the usual standard time. The amount settled out may be considered as the amount that can be removed by plain sedimentation.

Two or more Imhoff cones (Fig. 2) are used. These are marked near the top with a ring to indicate 1 liter or 1000 ml. (1.05 quarts) and at the bottom are graduations so that 50 or 100 milliliters can be read quite exactly.

These cones are filled with well-stirred sewage to the 1 liter mark; after about 15 minutes rotate the cone gently, reversing the direction of rotation 3 or 4 times. This should be repeated again about 5 minutes before the final reading. This permits material clinging to the sides to move down, and also levels out the material at the bottom.

About 90% of the settleable solids are deposited in the first half-hour, 95% in the first hour, and nearly 100% in 2 hours. The amount of deposited material may be read directly by the graduations at the bottom of the cone. Its denseness should be noted.

Results obtained when the reading is made directly by means of the graduations are comparative only because the solids are rarely packed closely enough to indicate actual volume. For exact results, the liquid, called the *supernatant*, should be drawn off and the total solids determined; also the total solids of the settled material. From these, the proportion that settles can be computed easily.

This test should be made at the same hour each day, and in exactly the same manner. Additional samples taken at other hours are often valuable checks. Note results in milliliters per 1000 mls. or, better, in parts per million. Keep the cones clean with a long-handled brush, hot water and soap; grease on the inner walls interferes with good settling.

Total Solids.—The total quantity of solids in a sewage is determined by evaporating a known volume of sewage, as described in *Standard Methods*, and weighing the dry residue. Using 100 ml., this is evaporated in a weighed platinum, porcelain or silica dish and the residue is dried for an hour at 103° C. The residue is then weighed in the dish and the original weight of the dish subtracted, giving the weight of the dried residue. If the original sample was 100 ml., the parts per million of solids in the sewage is found by multiplying the weight in milligrams of the sample by 10.

If this dried residue is then heated to redness (or ignited) most or all of the volatile or organic matter is burned off and the remainder represents approximately the amount of inorganic matter in the sample.

RELATIVE STABILITY TO METHYLENE BLUE

Ratio of Oxygen Available to Oxygen Required For Temperature of 20°C

Days Required for Decoloring	*Relative Stability*	*Days Required for Decoloring*	*Relative Stability*
½	11	6	75
1	21	7	80
1½	30	8	84
2	37	9	87
2½	44	10	90
3	50	11	92
4	60	12	94
5	68	13	95

pH Value.—The alkalinity or acidity of sewage is generally measured only by its intensity, which is shown by its pH value. The neutral point—neither acid nor alkaline — is indicated by pH 7. Smaller numbers indicate acidity, and the smaller the number, the more intense the acidity. Thus 6.4 is acid, 6.0 more acid, and 5.5 even more so. Numbers from 7 to 14 indicate alkalinity; 7.6 is slightly alkaline, 8.0 more alkaline and 9.2 still more intensely alkaline.

Indicators have been developed which, by different shades of color, show the pH. It is best to purchase one of the several very satisfactory pH comparators and to follow the simple directions furnished. Such equipment is not costly, and is far superior to any substitute device. For sewage work, equipment for electrical determination is best.

Determination of pH values are useful in sludge digestion and treatment; necessary in chemical coagulation; and desirable in ordinary plant operation. A daily record should be made at some selected hour—the same every day. Additional tests at different hours to show variations in the sewage pH are valuable from time to time.

Residual Chlorine. — When chlorine is fed into sewage, the amount required is determined by the amount of chlorine remaining in the sewage 15 minutes after it has been applied. Experience has shown that if there is a residual of about 0.5 ppm., after 15 minutes, the dosage of chlorine has been sufficient.

The test most commonly used employs orthotolidine as a color reagent. The orthotolidine solution can be purchased from the manufacturer of the chlorinator, from laboratory or chemical supply firms, or made up as directed in "Standard Methods."

The test is best made by means of a chlorine comparator, available from laboratory supply firms, or it may be made with bottles, test tubes or Nessler tubes in the laboratory. Place 100 cc. of sewage in a Nessler tube, allowing it to stand until 15 minutes after chlorination, unless 15 minutes has already elapsed since the chlorine was applied. Add 1 cc. of orthotolidine solution, mix and allow to stand 10 or 15 minutes. In cold weather warm slightly. Note the color. A color scale is desirable; comparators have such color standards. In general a lemon yellow coloration indicates a proper dosage.

The starch iodide test may also be used. For details see "Standard Methods."

The test for residual chlorine should be made daily or oftener at a standard time and results recorded.

Methylene Blue or Putrescibility.—This test measures the stability of a sewage effluent, that is, the length of time that elapses before the sewage putrefies. The test can be used on raw sewage, but is much better adapted to treated effluents, particularly these from trickling or sand filters. It cannot be used for sewage or effluents that have been chlorinated. While the relative stability measures approximately the biochemical oxygen demand, results obtained by it cannot be converted into BOD results.

The methylene blue solution is made up (see Standard Methods) or purchased ready for use. In making the test, a bottle with a glass stopper must be used; an 8-ounce bottle is a good size. Fill the bottle completely, preferably by immersing or by a siphon; avoid agitation and the introduction of air bubbles. Add to the 8-oz. or 250-cc. bottle, 0.7 cc. of methylene blue; to other size bottles in proportion. See that no air bubbles remain under the stopper. Hold the bottle in an incubator at 20° C (68° F) until the blue color disappears. If no incubator is available, the sample can be kept at room temperature, which is ordinarily about 20° C, or in water. Incubation at 37° C will give quicker but less accurate results. Note the time in days required for the sample to lose its color, and from the accompanying table note and record the relative stability.

When a temperature of 37° C is used, exactly one half as many days are required, and the foregoing table can be employed for reading the results. For instance, if decolorization occurs in 3 days when incubated at 37°, results are the same as for 6 days at 20° (or 75%). If decolorization occurs in 1½ days at 37, results are same as for 3 days at 20° (50%).

Biochemical Oxygen Demand.—This, usually abbreviated to B. O. D. (in this text to BOD), shows the oxygen required in parts per million to stabilize the decomposable organic matter in the sewage. Actually, a long time is required for complete stabilization—100 days or even more; but it is impossible to run tests for this length of time, and a 5-day period is usually employed, holding the sample at 20° C. Actually about 68% of the oxidizable organic matter under-

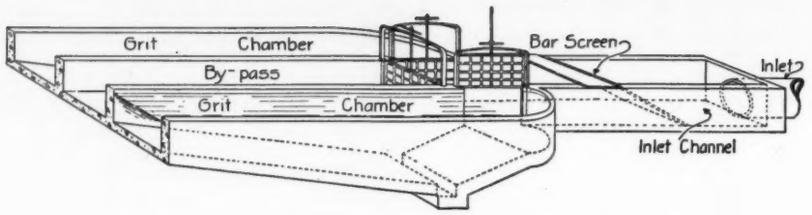


Fig. 3. Old type bar screen and hand-cleaned grit chamber

goes decomposition under these conditions, but results are, of course, comparable with results from other plants or obtained at other times. Therefore, 5-day BOD tests are commonly employed in recording the results of operation.

This test employs small quantities of sewage, (in raw sewage dilutions of 99% to 99½% of distilled and aerated water are usual), and considerable care along with proper technique, are required for accurate results. The newer amidol method is simpler and easier than the older Winkler method, but both require care and some actual practice. Because of these factors, methods of making the test will not be given here. It is recommended that operators arrange with their state boards of health for instruction and, if possible, take one of the short courses provided, usually at the state universities. Complete details of both tests are given in the 1936 edition of *Standard Methods*. If the operator desires to make the test, each step as outlined in *Standard Methods* should be carefully studied in advance. It is recommended that if this be done, a careful record of results be kept for comparison and checking.

The presence of chlorine, unless neutralized and the sample seeded, makes results unreliable.

Dissolved Oxygen.—On raw sewage, the dissolved oxygen (abbreviated DO) test measures the amount of oxygen remaining in the sewage, and is an indicator of the freshness of the sewage. It is also used on effluents, especially from trickling and sand filters and activated sludge plants, and in determining stream conditions. Analyses of samples taken in a stream above and below the sewer outlet indicates the effect on the stream of the sewage discharge.

This test is also a part of the Winkler method of determining B. O. D. and the same comment applies as to the BOD test.

Grit Chambers and Coarse Screens

Grit Chambers

All sewage seems to carry in suspension some sand, grit, cinders and other material of the sort. Combined sewers (those that carry both storm water and house sewage) carry most, but even in the small plant treating only ordinary domestic sewage, a considerable amount of such coarse material arrives in the sewage. In Imhoff tanks this makes the sludge hard to handle, and in separate sludge digestion plants it may cause the same trouble also. When sewage is pumped, such material causes rapid wear in the pumps.

Sand or grit may also clog or interfere with the working of valves and gates and, where there are inverted siphons, may wholly or partially clog these.

Removal Methods.—The sand, cinder particles and similar material being heavier will settle more quickly than the organic matter in the sewage. Removal is therefore accomplished by providing an enlarged place in the sewer—called a grit chamber—which slows down the velocity of the sewage to about 1 foot per second, at which velocity the sand and other grit will settle, while the organic matter does not.

The flow of sewage varies, being larger during the day than at night. It is therefore difficult to design a grit chamber for all volumes of flow. In older designs this is usually accompanied by providing such grit chambers with two, or more channels or compartments one or more of which can be used, depending on the flow. In newer, mechanical units, other provisions are made.

Types of Grit Chambers. — Older plants are commonly equipped with the type of basin shown in Fig. 3. In actual operation, except in large plants, cleaning and grit removal is difficult and disagreeable and very liable to be neglected in the average plant.

Newer devices, include the Dorr "Detritor", Fig. 4, which provides for mechanical removal and washing of the grit, so that the material removed is relatively clean and unobjectionable; also the Chain Belt grit collector and washer and the Link-Belt, Fig. 5. In the Dorr, the revolving arms scrape the grit into a channel, from which it is drawn up and out by a rake. In the Link-Belt equipment, the grit is scraped to the end of a relatively narrow and long chamber and then removed by means of a screw conveyor. Link-Belt has provision for using small aerators to keep the sewage passing through the tank at a uniform spiral velocity, thus providing for considerable variations in flow. Jeffrey has a grit remover somewhat similar to Link-Belt. Chain-Belt uses a bucket-type remover to scrape the grit from the channel and elevate it to a sluice trough, whence it is washed and dewatered.

Operation.—When modern mechanical equipment is used, operation consists of final disposal of the washed grit, which can be used for fill; and in lubricating and maintaining the equipment in accordance with the manufacturer's directions.

In the older types of grit chambers, cleaning is necessary after every heavy storm, as a rule, and also when it is determined by measuring with a pole marked to feet and inches, that the channels are half full or more. In dry weather, measurements should be made once a week. Removal is accomplished by shutting off the flow in the compartment or channel to be cleaned, pumping or bailing out the sewage, and removing the residue with shovels, pails or, in large plants, with grab buckets. Such grit usually contains so much organic matter that it should be buried; but if sufficient space

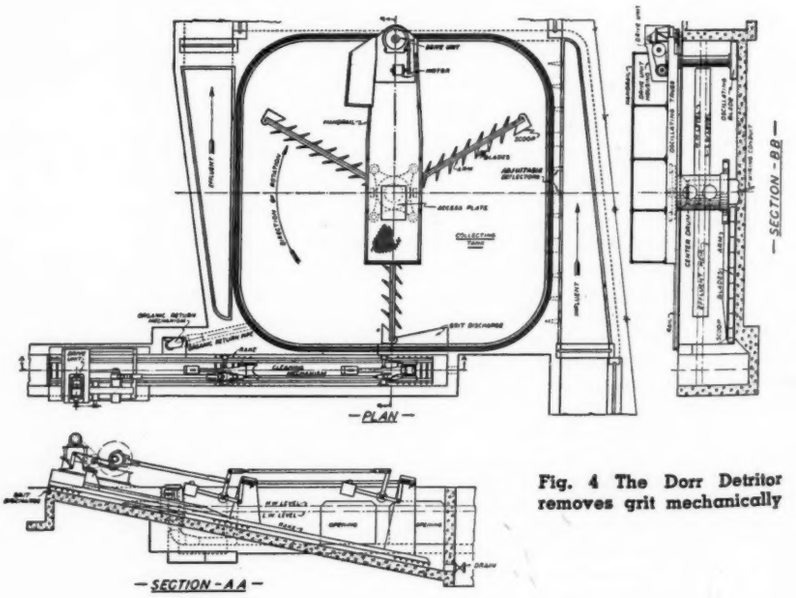


Fig. 4 The Dorr Detritor removes grit mechanically

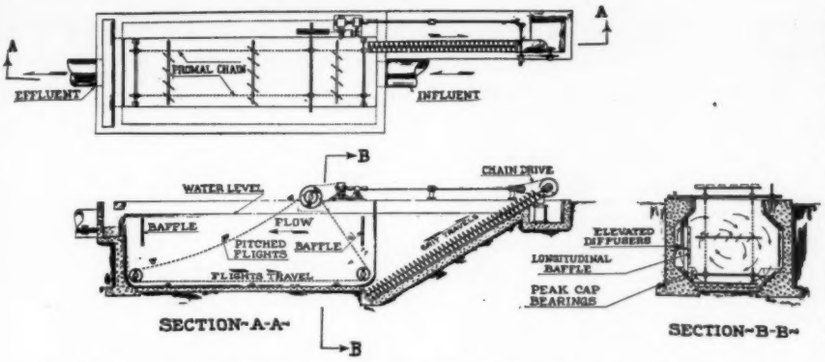


Fig. 5. Spiral flow grit chamber, with "Straightline" collector and dewatering screw

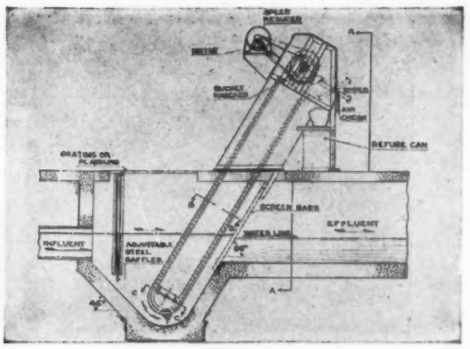


Fig. 6. Section of "Tritor" screen

is available it may be dried on sludge beds at some risk of causing odors.

Operating Records.—When mechanical washing and removal apparatus is used, a daily record should be made of the amount (generally in cubic feet) of material removed. This may be entered on the daily report in a column adjacent to the volume of flow and to the volume of screenings.

When grit chambers must be cleaned by hand, the dates of cleaning and the amount of material removed should be noted; also days since last cleaning and notations regarding storms.

Screens and Screening

The purpose of screens is to remove large objects in the sewage. Such objects tend to clog pumps and pipe lines and to interfere with plant operation.

The term screens, as used here, refers to a screen made of iron bars, spaced ½ inch or more apart. The bars are usually set at an angle to facilitate cleaning. Cleaning is done by hand, or by a rake on the mechanically cleaned screens. Hand cleaning is a disagreeable job, often neglected; mechanically cleaned screens are preferable.

An area between the bars about twice as great as the area of the entering and leaving sewer is desirable.

Types of Screens.—In addition to the hand cleaned screens, there are several type of mechanically cleaned machines. These include the Tritor, by Link-Belt, Fig. 6, which is a combined grit chamber and screen. The sediment of grit and sand settles in the pocket at the foot of the screen, and is removed by means of a bucket. The edge of the bucket also cleans the screen.

Mechanically cleaned screens are made by Dorr, Jeffrey, Chain-Belt, Link-Belt, and Filtration Equipment.

In addition to convenience, such screens are more effective than hand-cleaned screens because cleaning is more frequent. In the small plant, screens are raked by hand only once or twice a day, as a rule, whereas the mechanical screen can be set to operate as desired, as 3, 5, 10, 30 or 60 minutes, or intermediate intervals. As a result, about twice as great a volume of screenings is removed.

Operation of Screens.—Hand cleaned screens should be cleaned several times a day, otherwise the sewage is backed up by the material caught on the screens. This not only may cause deposits in the entering sewer, but may also force some of the material through the screen thus rendering it less effective. The screen chamber should be hosed and squeegeed weekly, or oftener in warm weather.

Mechanical screens should be lubricated in accordance with the manufacturers' suggestions. The screen, buckets, and the screen chamber should be hosed daily to keep them clean, and the chamber walls squeegeed at weekly intervals.

Disposal of Sreeenings.—The screenings removed are very disagreeable. Prompt and sanitary disposal is necessary. With hand cleaned screens, the rakings from the bars can be shoveled into a wheelbarrow. Mechanically cleaned screens may discharge direct into wheelbarrows or into closed cans. Burial is the most common method of disposal, but in many plants such a small amount of cover is given that rats and even flies reach the material. A trench at least 3 feet deep is necessary, and spraying the screenings with creosote or covering with tar after dumping them into the trench is desirable. Cover at once and thoroughly with at least 18 inches of cover.

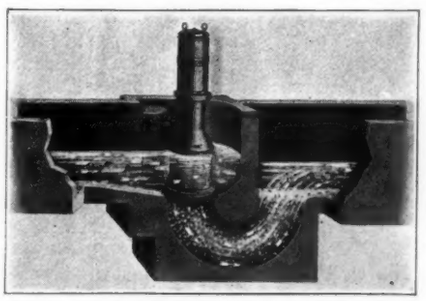


Fig. 7. Comminutor installed in sewer

It is possible to use gas from the digester of a separate sludge digestion plant to burn the screenings. This insures sanitary disposal. There are also a number of screenings shredders now available. These cut or grind the screenings to small bits and return these to the sewage for final disposal by sedimentation and digestion.

Screenings Grinders. — Chain-Belt, Jeffrey, Gruendler and Chicago Pump have cutters or grinders for disposing of screenings. The three former are used in connection with mechanically cleaned screens; the last acts also as its own screen. The Chicago Pump "comminutor" is shown in Fig. 7; the Chain Belt "Triturator" in Fig. 8.

Grit should be removed before grinding, otherwise the cutting edges of the teeth wear and must be replaced at intervals.

Records of Operation. — Records should show the amount of screenings removed daily, which is easiest measured by noting the capacity of the wheelbarrow used (usually about 3 cu. ft.) and the number of times it is filled. On the mechanically cleaned screens, a record should be made of the time setting between strokes—as 5 minutes or 10 minutes; also of the amount of material removed. When the screen discharges directly into a grinder or when a comminutor is used, there is commonly no record of the amount removed, but measurements may be made from time to time for purposes of record.

Sedimentation Tanks

This section covers the operation of sedimentation tanks equipped with apparatus for the collection and removal of sludge. It does not refer to septic tanks, to hopper bottom settling tanks, nor to Imhoff tanks, on which a separate section has been prepared.

For preaeration for grease removal, see page 64 of this issue.

Purpose of Sedimentation.—The purpose of sedimentation is to remove as much as possible of the solids carried by the sewage, specifically that which will float or settle out, to separate this material from the sewage and to treat and dispose of it separately. Such treatment does not produce a "pure" effluent; it

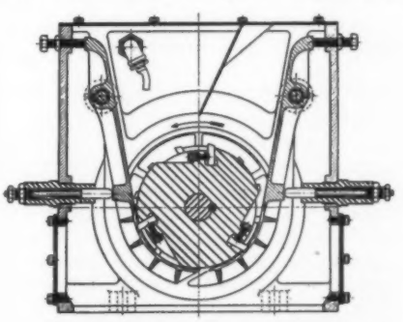


Fig. 8. Cross section of triturator

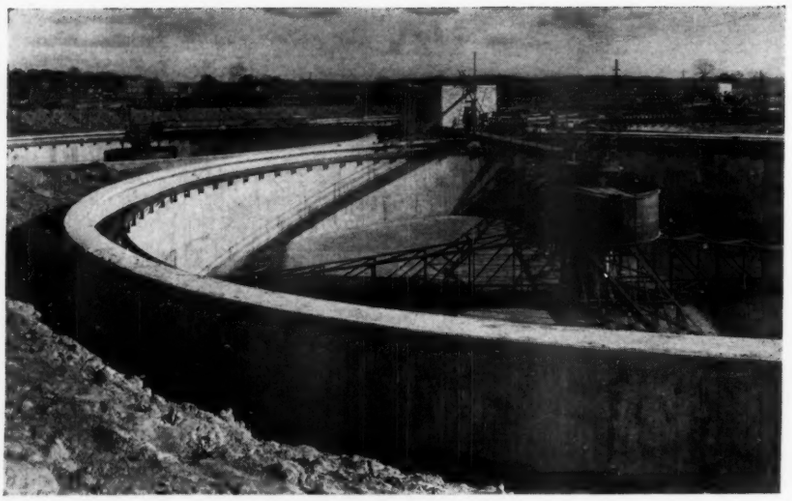


Fig. 9. Dorr "Sifeed" clarifier at Washington, D. C.

does, however, represent a considerable step forward in the process of treatment. From 50% to 60% of the suspended solids are ordinarily removed and from 10% to 30% of the total solids.

Design of Settling Tanks.—Settling tanks are generally circular or rectangular in shape, but some are square. The circular and the rectangular, with a length four or five times the width, are most common. Most tanks built now-a-days are not over 9 or 10 feet in depth, since experience has shown these are as effective as deeper tanks and cost less to construct; but with larger tanks, greater depth is desirable. The capacity of the tank—the width times the length times the depth—should be equal to the average flow of sewage over a 2 or 3 hour period. For instance, a tank 70 ft. long, 10 ft. deep and 15 ft. wide has a capacity of 70 x 10 x 15 = 10,500 cubic feet, or 78,750 gallons. With a detention period of 2½ hours, such a tank would treat 78,750 x 24 ÷ 2.5 = 756,000 gallons per day.

A circular tank 40 ft. in diameter and 10 ft. deep has a capacity of 40 x 40 x .7854 x 10 = 12,656 cu. ft. or 94,250 gallons, and with a detention capacity of 2.5 hours, would have a capacity of about 905,000 gallons.

To find the capacity of your own settling tanks in gallons, multiply the length times the width times the water depth by 7.48.

Types of Tanks.—The types of tanks mentioned are represented by the Dorr, Link-Belt, Hardinge and Chain Belt circular tanks, and the Link-Belt, Chain Belt, Hardinge and Jeffrey rectangular.

Fig. 9 represents the Dorr tank. The sewage enters through the inlet pipe at the bottom, and is fed into the tank through the diffusers the openings being near the bottom of the central feed. The sewage flows slowly to the edges of the circular tank and over a circular outlet weir into a channel, the settleable solid matter meanwhile settling to the bottom. A revolving arm, to which is attached scrapers, collects this settled matter or sludge to a sump at the center of the tank from which it is removed by means of a sludge pump.

Except for the central diffuser, the Hardinge tank is very similar to the Dorr tank. The circular Link-Belt tank is also similar to the Dorr, except in the scraping mechanism. Chain Belt has a suction type sludge remover, the Tow-Bro.

Fig. 10 represents a Straightline equipped settling tank. The sewage enters through the influent channel and into the tank through slots in the end wall, passing slowly through the tank, under the scum-trough and baffle at the end and into the effluent channel. The solids that settle to the bottom are collected in the sludge hopper at the influent end of the tank by means of scrapers or flights attached to endless chains, as shown in the illustration; and these flights are so arranged that they also scrape the scum that collects on the surface of the sewage in the tank to the scum trough at the outlet end of the tank, whence it can be removed by the operator.

The Chain Belt and Jeffrey tanks are very similar to the Link-Belt tanks, differing only in details. Hardinge rectangular tanks use crane type equipment for sludge collecting and skimming.

Operation of Tanks.—Sludge is removed continuously in some plants, and once or twice a day in others. In the Dorr clarifiers and also in some of the others, the scrapers are kept in slow, continual motion. The sludge is drawn from the sludge sump in the bottom of the tank by means of pumps, which also usually operate twice a day on small plants and continuously on large ones, discharging sludge into the digestion tank. In this type of operation, the operator should take frequent samples of the sludge being drawn (provision is usually made for easy sampling) and adjust the pump capacity so that the sludge is drawn, but no more. If sewage is being drawn, the pump should be regulated to draw off less material from the tank.

When the collectors are run intermittently, as for one hour twice a day, the pumps should be started as soon as the collectors are put in motion, and should be allowed to run as long as they draw sludge from the tank. In some tanks, pumps are not used, but the pressure of the sewage in the tank is employed to force the sludge out through a pipe, either into the digestion tank, or to a pump sump. With this equipment, the collectors are usually allowed to run for one or two complete revolutions before sludge is drawn. According to the speed at which the collector is geared, a complete revolution of the flights may take from 30 to 90 minutes, or more. Generally two or three revolutions are permitted, this being sufficient to remove the sludge from the bottom of the tank.

When the sludge is drawn by hydrostatic pressure, that is by the pressure of the sewage in the tank, the valve on the pipe is opened part way, and the sludge allowed to flow out; when sewage begins to appear, the valve should be closed. Most plants are so designed that the operator can see the the sludge as it is being drawn, and can judge when the valve should be closed.

Some floating material collects on the top of the tanks. Mechanical apparatus is now commonly used to remove such material. Where it is not available, hand removal at least once a day is necessary. Appearance is the principal factors for guidance in this. Skimmings are usually placed in the sludge digestion tank. Most plants are so designed that these skimmings may be swept into a trough which discharges into the digester or into the pump sump so that further handling is not necessary.

The side walls of the settling tank sometimes collect fine solids, which in warm weather decompose; also at the water line, some grease is deposited. This should be removed daily with a stiff brush or with a squeegee, and the walls washed down with a hose. It is desirable to squeegee the side walls of the tank to prevent the deposit there from peeling off and coming to the surface as dark floating pieces of organic matter. This is not easy, but is necessary in warm weather.

The inlet channel should be washed out with a hose every day and scrubbed

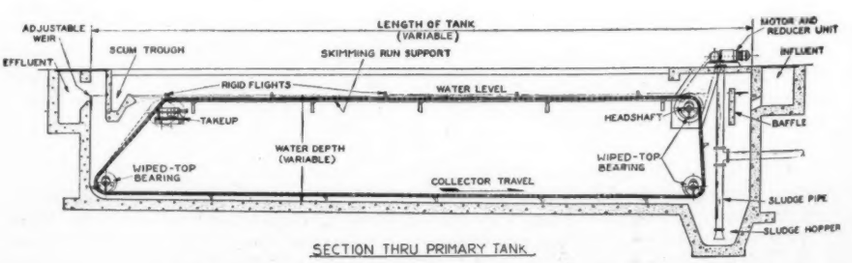
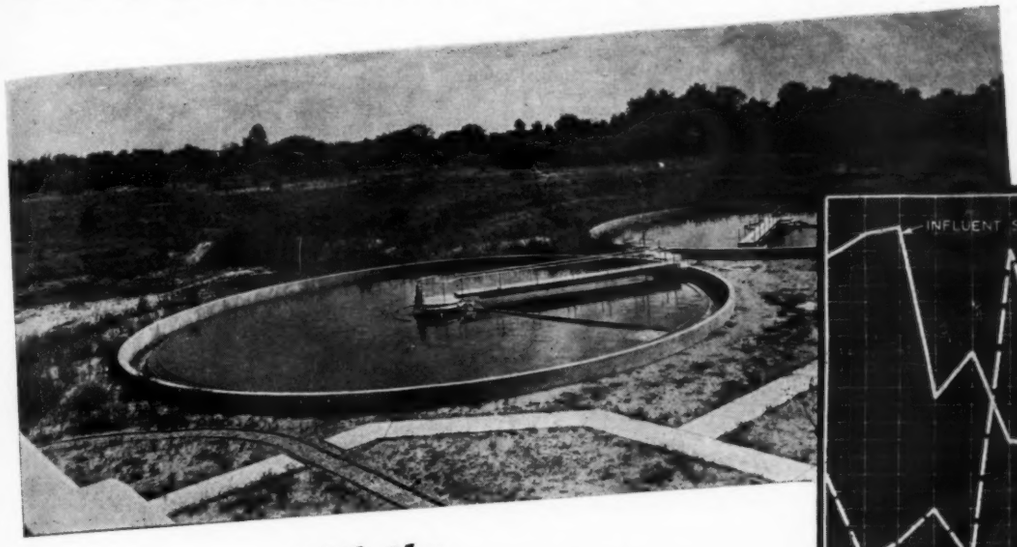
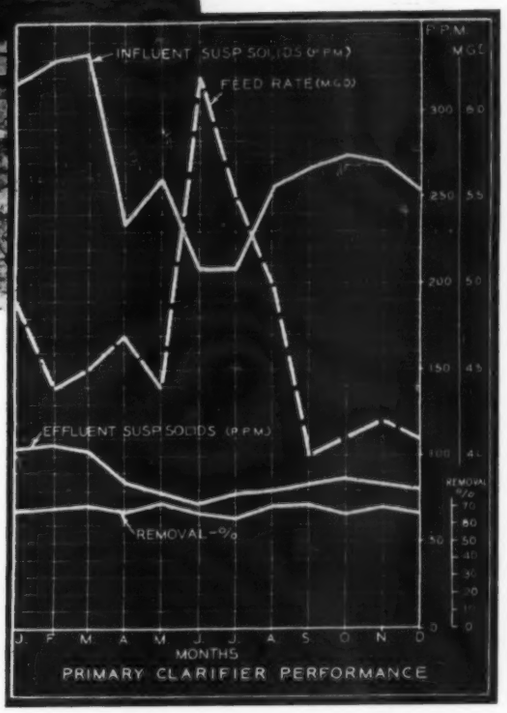


Fig. 10. Typical "Straightline" type sludge collector

HIGH REMOVALS *under variable feeds*



Left: Dorr Clarifiers at Battle Creek



with the DORR SIFEED CLARIFIER

70.2% Removal Suspended Solids
98.6% Removal Settleable Solids
32.2% Reduction in B. O. D.
94.5% Moisture Sludge

DORR SIFEED CLARIFIERS thrive on a variable feed. The distinctive "Sifeed" principle smooths out fluctuations in feed volume and feed concentration and contributes to the uniformly high removals and uniformity good effluents secured.

The operating data at the right were collected by N. G. Damoose, Engineer-Manager of the Battle Creek, Michigan, Sewage Treatment Works. They cover a one years' test of two 80' primary Dorr Sifeed Clarifiers. Samples were composited daily and results averaged monthly.

The Dorr Sifeed principle assures uniform feeding, distribution and overflowing, regardless of variations in influent. Feed enters centrally through a submerged diffuser, is distributed radially and reaches the minimum velocity at the point of take off.

The continuous peripheral overflow weir is of maximum possible length and at all points is equidistant from the point of feed inlet.

DORR CLARIFIER PERFORMANCE

Jan. 1-Dec. 31, 1937

Clarifier Feed*	Average	Max.	Min.
M. G. D.	4.67	6.24	4.00
Temp.—Deg. F.	62°	67°	57°
pH Value	6.93	7.13	6.72
B. O. D.'s			
Influent—ppm.	215	289	155
Effluent—ppm.	145	206	112
Reduction—per cent	32.8	32.2	29.7
Suspended Solids			
Influent—ppm.	267	333	207
Effluent—ppm.	86	107	71
Removal—per cent	67.9	70.2	63.3
Settleable Solids			
Influent—cc/liter	5.8	8.1	3.8
Effluent—cc/liter	.008	.20	.00
Removal—per cent	98.6	100.0	96.0
Settled Sludge			
Moisture—per cent	94.5	95.5	93.6
Volatile Matter—per cent	82.3	86.5	77.8

*Samples collected after screening and grit removal.

DORRCO

THE DORR COMPANY INC.

ENGINEERS • 570 Lexington Ave., New York

ATLANTA • TORONTO • CHICAGO • DENVER • LOS ANGELES

DORR TECHNICAL SERVICES AND EQUIPMENT ARE ALSO AVAILABLE FROM THE FOLLOWING COMPANIES:
NETHERLANDS: Dorr-Oliver N.V., The Hague • ENGLAND: Dorr-Oliver Company Ltd, London • GERMANY: Dorr Gesellschaft, m.b.H. Berlin • FRANCE: Soc. Dorr-Oliver, Paris
ITALY: S.A.I. Dorr-Oliver, Milan • JAPAN: Sanki Eng. Co., Ltd., Tokyo • SCANDINAVIA: A.B. Hedemora, Hedemora, Sweden • AUSTRALIA: Crossle & Duff Pty. Ltd., Melbourne
ARGENTINA: Luis Fiore, Buenos Aires • SOUTH AFRICA: Edward L. Bateman Pty. Ltd., Johannesburg • BRAZIL: Oscar Taves & Co., Rio de Janeiro

at least once a week, using a stiff broom; the same treatment should be given to the outlet channel and to the baffle.

Manufacturers furnish with their equipment a lubrication chart which shows where to oil and grease and tells what kind of lubricant to use. These instructions should be followed very carefully. The motors and reducers are complicated pieces of apparatus, and even though the collector itself travels slowly, this is only because of gear reducers, parts of which travel at a high speed. If the lubrication chart has been lost, write to the manufacturer of the sludge collecting apparatus and ask for another one.

It is good policy to empty a tank every six months, inspect the machinery and make necessary adjustments. This is especially the case with new plants, as takeups and scrapers may need adjustments.

Records of Operation.—For sedimentation tanks of this type, the records of operation should include at least the following: When and for how long the collecting apparatus is run; volume of sludge removed, preferably in cubic feet; temperature of the sludge removed; pH of the sludge; and settleable solids daily of both the raw sewage and the tank effluent.

Sludge Digestion Tanks

The disposal of the sludge that is deposited in the bottom of sedimentation tanks is one of the serious problems in the operation of a sewage treatment plant. This material is highly decomposable and offensive. Generally the best method of treatment is by digestion. In this, the sludge is stored in deep tanks for 30 to 50 days, during which time the organic matter is digested and converted into more stable forms. After this digestion process, the sludge can be dried on sand beds without nuisance.

Moisture Content.—Most sludges contain from 90% to 98% of water. To realize what effect this has on the volume, it is easier to consider the solid matter present. Thus, with a sludge that is 98% water, there are only 2% of solids present; if the sludge is 96% water, there are 4% of solids present, and for the same amount of solids, only ½ as much water. In other words, a 96% sludge is only half as bulky as a 98% sludge. For the same amount of solids, a 98% sludge occupies five times the space that a 90% sludge does.

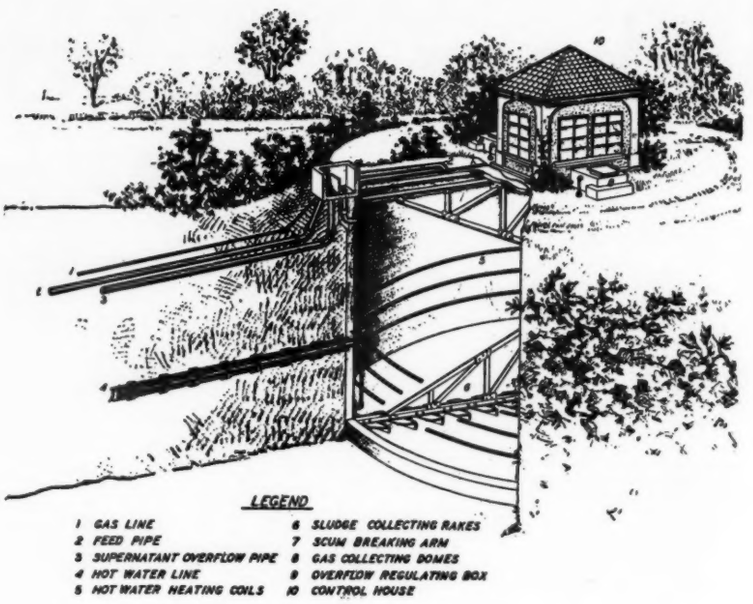


Fig. 12. Sketch of Dorr digester

Amount of Sludge.—The moisture content has such a bearing on the volume of sludge that it is difficult to make a statement as to the volume of sludge to be expected. The only basis on which to make a comparison is that of the amount of dry solids, which is secured by evaporating the sludge to a bone-dry condition. The usual sewage treatment plant will remove from 100 to 300 pounds of dry solids per 1000 population or 1/10 to 1/3 pounds per person per day. The actual volume of sludge varies from 2500 to 10,000 or more gallons per million gallons of sewage.

Sludge Digestion Tanks.—Tanks for sludge digestion are normally built of concrete. Some are provided with stirring equipment; others rely on natural changes for whatever mixing is necessary, as from the addition of fresh sludge and drawing out the digested sludge. There is a difference of opinion as to the need for or value of stirring. In the average plant, there is provided about 2 to 3 cubic feet of sludge digestion space—17 to 25 gallons—per person connected to the sewer system.

Sludge digests best at a temperature of 80° to 95° F. Sewage is much cooler than this—usually around 45° F to 70° F. Therefore in most tanks it is desirable and economical to heat the sludge, since digestion is more rapid and a smaller tank can be used—2 to 3 cu. ft. per person is probably enough for a heated tank, but at least 3 or 4 cu. ft. per person is necessary for an unheated one. This heating is usually accomplished by means of hot water pipes placed around the inside of the tank, as shown in Fig. 12 and the water is heated by burning the gas that is formed during the digestion of the sludge. This gas, which is largely methane—about 65%—has a heat value of around 700 b. t. u. per cubic foot. About 1 cu. ft. per person per day is produced on an average, but this ranges from 0.6 to 1.5 cu. ft., or sometimes more.

The Dorr Digester.—Fig. 12 shows a section of a Dorr digester, which is not of the latest type, but which illustrates the principles of operation. The digester is underground, or covered with earth to conserve heat. The hot water pipes to heat the sludge are shown marked (5), and the other principal equipment is also indicated by numbers and identified in the legend.

The Dorr 2-stage or multdigestion system is shown in Fig. 13. In this method there are two tanks. The greater part of the work of digestion is accomplished in the primary tank, which is heated. This is equipped with mixers. Final digestion takes place in the secondary digester, which is equipped with a gas holder. Pacific Flush Tank Co. also makes a 2-stage digester, Fig. 13a.

The PFT Floating Cover.—Fig. 14 shows a digestion tank equipped with a Pacific Flush Tank Co. floating cover.

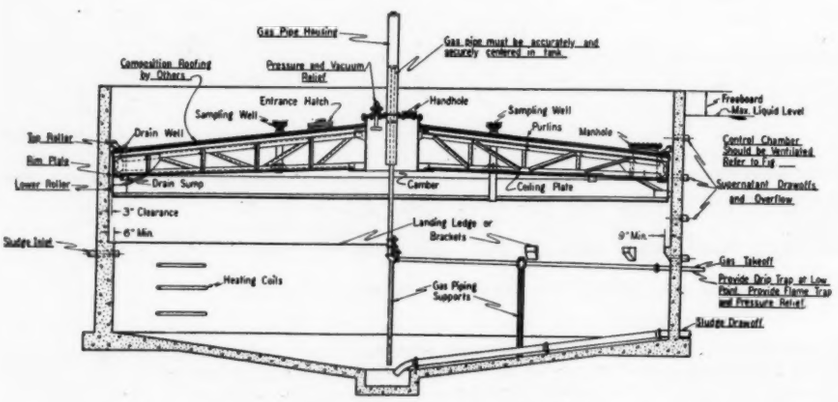


Fig. 14. PFT digester and floating cover

Is there a substitute for *EXPERIENCE?*

We say "no!" We have encountered too many sanitation projects which failed to function as planned because experience was sadly lacking in the design and manufacture of the equipments used.

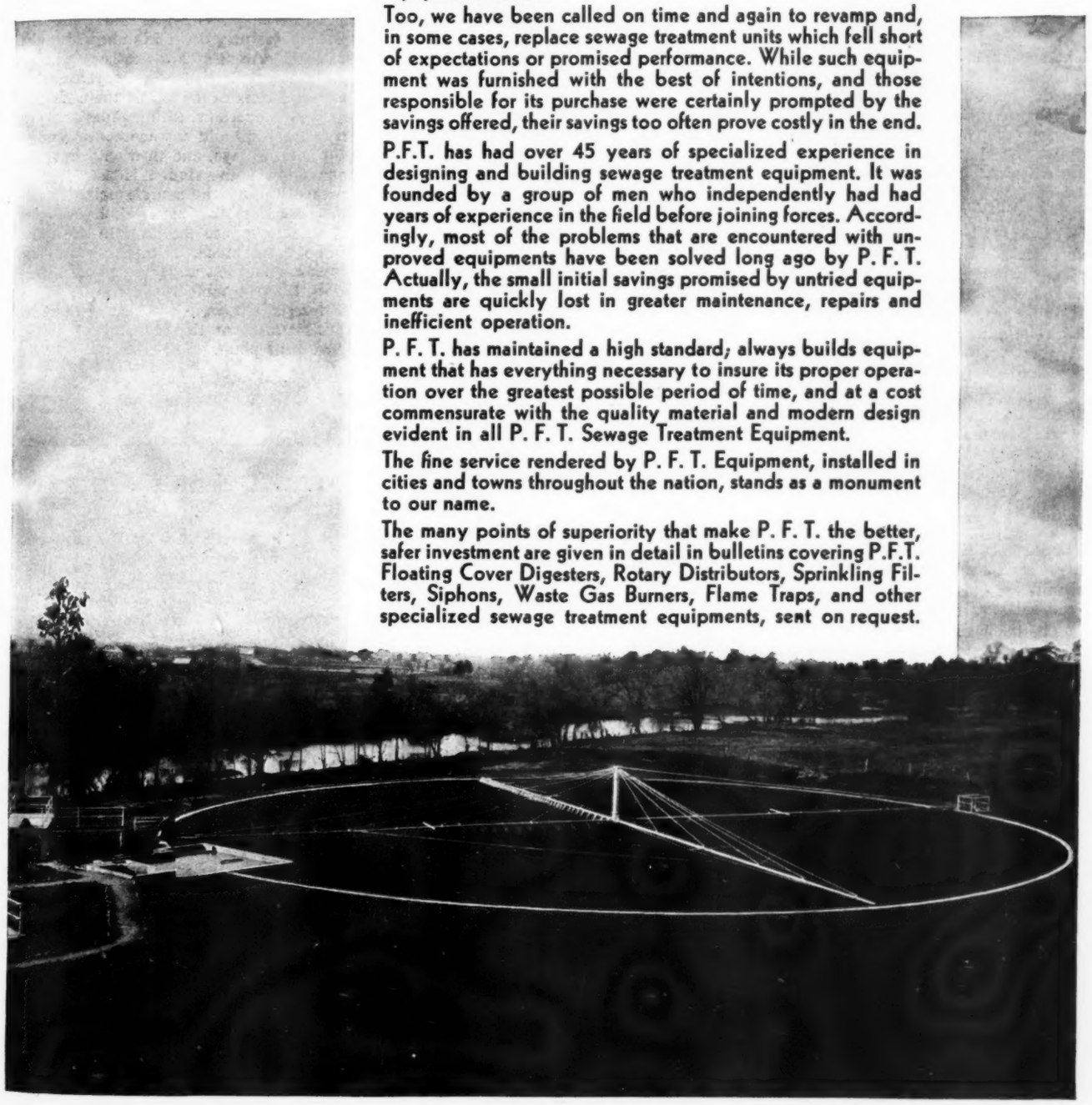
Too, we have been called on time and again to revamp and, in some cases, replace sewage treatment units which fell short of expectations or promised performance. While such equipment was furnished with the best of intentions, and those responsible for its purchase were certainly prompted by the savings offered, their savings too often prove costly in the end.

P.F.T. has had over 45 years of specialized experience in designing and building sewage treatment equipment. It was founded by a group of men who independently had had years of experience in the field before joining forces. Accordingly, most of the problems that are encountered with unproved equipments have been solved long ago by P. F. T. Actually, the small initial savings promised by untried equipments are quickly lost in greater maintenance, repairs and inefficient operation.

P. F. T. has maintained a high standard; always builds equipment that has everything necessary to insure its proper operation over the greatest possible period of time, and at a cost commensurate with the quality material and modern design evident in all P. F. T. Sewage Treatment Equipment.

The fine service rendered by P. F. T. Equipment, installed in cities and towns throughout the nation, stands as a monument to our name.

The many points of superiority that make P. F. T. the better, safer investment are given in detail in bulletins covering P.F.T. Floating Cover Digesters, Rotary Distributors, Sprinkling Filters, Siphons, Waste Gas Burners, Flame Traps, and other specialized sewage treatment equipments, sent on request.



P.F.T. *Pacific Flush-Tank Co.*

4241 RAVENSWOOD AVENUE, CHICAGO
NEW YORK CHARLOTTE, N.C. LOS ANGELES

SEWAGE TREATMENT EQUIPMENT EXCLUSIVELY SINCE 1893

When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 71-73

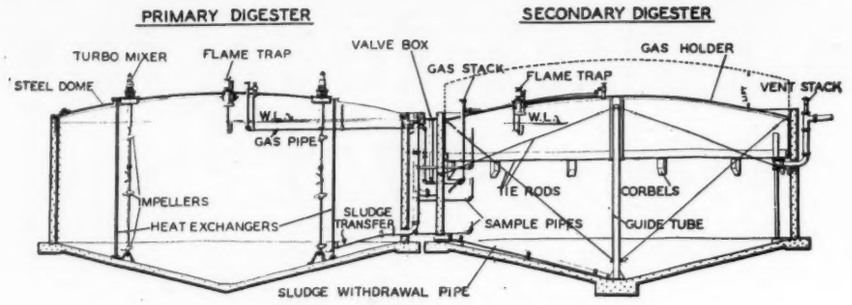


Fig. 13. Section of digesters, Dorr "Multdigestion" system

The sludge enters the tank through the sludge inlet. No stirring devices are provided. The cover floats on the surface of the sludge, and the gas is collected in the gas chamber at the top. Sludge is drawn off from the bottom. The principal parts of the digester are indicated in the drawing.

Operation Details.—Sludge is normally added either continuously or once or twice a day. Sludge should be completely removed from the settling tanks, but excess sewage should not be drawn. It is not generally possible to store or hold sludge; the digestion tank must be capable of taking all the sludge that is produced every day.

Some operators prefer stirring or recirculating; others break up the scum; others do not mix at all, but rely on the digestion process and the daily adding of new sludge to accomplish whatever mixing of the raw sludge and digested sludge is desirable. Whatever type of plant is provided, the operator must operate it as best he can; that is, if his digesters are equipped with stirrers, these should be run; if not so equipped, he need not worry about stirring.

The hot water pumped into the heating coils of the tank is generally maintained at a temperature of about 120° F to 130° F. A temperature much higher than this will tend to char the sludge on the outside of the pipes and cause loss of heat conductivity. The contents of the tank are kept at from 80° F to 95° F. Thermometers record the temperature of hot water and of the cooler return water; also of the temperature of the digesting sludge.

Sludge is removed when it is fully digested, or when the tanks are full and sludge drying beds are empty. The former is desirable; the latter may be necessary. Most digesters are provided with devices for sampling the sludge, so that only fully-digested sludge need ordinarily be drawn. Well digested sludge is usually granular in appearance, without any pronounced odor, and dark or nearly black in color. Too much sludge should not be removed at one time. To do this may rob the tank of the "ripe" sludge and leave an insufficient amount of this to mix with the fresh sludge added every day. Ordinarily, when sludge is drawn, the sludge drying bed unit is filled to capacity. This is necessary because the number of drying beds available is usually limited and each must be worked nearly to capacity. When drawing the sludge, the operator should watch the sludge and cease drawing it whenever any change in appearance is noted that indicates improperly digested sludge. Generally not over 10% to 20% of the capacity of the digester should be drawn at one time.

Frequent pH tests of the sludge should be made. This is not easy with ordinary pH apparatus, and electrical pH apparatus is recommended. If the color test method is used, the sludge may be centrifuged, which is not always satisfactory; filtered, which gives somewhat high results; or diluted with distilled water, allowed to stand and the pH taken on a clear portion. Sludge digestion proceeds most favorably at pH values of 7.0 to 7.6—preferably above 7.2, but many plants report good results with pH readings of 6.8.

If the pH value is below 7.0, it is usually desirable to try to raise it. This is most frequently done by adding lime to the sludge as it enters the digester. It is almost impossible to determine, except on the basis of past experience, how much lime should be added. A start might be made using ¼ to ½ pound per cubic foot of sludge, and more added if the pH value does not rise appreciably in a few days. This can be added at the sludge pump, or in the recirculation pump if there is one.

Activated carbon has been effective in some plants in raising the pH and in aiding digestion. It should be added in the form of a slurry, mixed with water to form a paste. It may be added at the rate of 15 to 25 pounds per million gallons of sewage; if each million gallons of sewage produces 10,000 gallons of sludge, and it is desired to dose the entire digester, add at the rate of 15 pounds per 10,000 gallons of sludge and note the effect, delaying adding more for a few days.

In many plants, the first year of operation of a digestion tank is a troublesome one. The operator should secure detailed directions from the designing engineer or manufacturer of the equipment installed in the digester, and should follow these instructions, calling for further help as needed.

Operating Difficulties. — Foaming may be due to acid sludge, to the addition of too much raw sludge at one time, to industrial wastes (as creamery, slaughterhouse, etc.), to too rapid digestion (as may occur in unheated tanks with the advent of hot weather), and to other reasons. A frothy, objectionable material rises to the top of the tank and may even overflow, filling pipes and gas traps. Do not add any more raw sludge for several days, and then only in small amounts. If the sludge is acid, try to bring it above the neutral point by adding lime or other material. Draw some sludge to reduce the level in the tank, but not too much, as this may rob the tank of the ripe sludge needed for digestion. If the trouble appears to be due to industrial wastes, try to correct these by pretreatment at the industry or at the treatment plant.

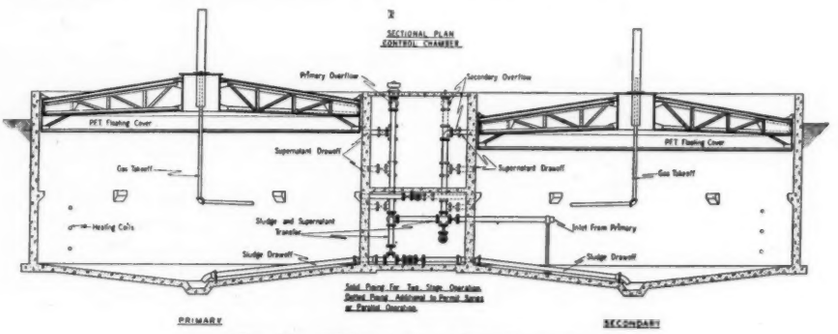


Fig. 13a. PFT two-stage digester section

In areas where the water contains considerable mineral matter in the form of sulphates, decomposition of these may take place in the digester with the production of hydrogen sulphide. If the tank is a closed one, and the gas is burned, there will be no odor; but the resulting acid may corrode meters, flame traps and perhaps piping. This is prevented by neutralizing the H_2S by passing the gas through iron oxide or other scrubbers; or by maintaining the gas at a high enough temperature to eliminate moisture in it, thus preventing the formation of the acid which is the corroding agent.

Utilizing The Gas.—The gas from digesters is commonly used for heating the water used to heat the sludge in the digester, and also for other purposes, as in the plant laboratory, for heating the plant buildings, and for operating gas engines to drive pumps, when pumping is needed. As already stated, this gas is explosive and equipment for handling it and utilizing it should be installed only by a manufacturer specializing in this work, and not by plumbers; nor should it

be homemade. For safety in sewage plants, see *Public Works*, Aug., 1938.

Supernatant Liquor. — The overflow from the digestion tank, or *supernatant*, frequently offers a problem in disposal, since both its solid content and its BOD are very high. It is rather common practice to pump this back into the inlet of the sedimentation tank. In some plants this method of disposal is satisfactory; in others it appears to affect adversely the quality of the effluent. Probably the strength of the supernatant, the capacity of the digester and the characteristics of the sewage are factors.

In plants using chemical coagulation, the supernatant return to the settling tanks often interferes with coagulation and usually increases the amount of chemical required to form a satisfactory floc. In plants employing either plain settling or chemical coagulation, interference by the supernatant can be reduced by returning it at periods of light load, as at night.

The supernatant amounts, in volume, to the sludge pumped from the settling tank less that drawn onto the drying beds. It may average around 15,000 gallons per million gallons of sewage, but may vary greatly from plant to plant. Some attempts have been made to treat it on sand beds, as on sludge drying beds; it can be coagulated by the addition of about 250 ppm. of aluminum sulphate followed by a short period of settling—about 15 minutes. There is no established satisfactory method of disposal. If the supernatant appears to interfere with proper operation of the settling tank, treatment on sand beds may be tried with the advice of your state sanitary engineer. If the supernatant appears to be of unusually bad quality, ask for advice from the engineer or the manufacturer of the digester apparatus, as the difficulty may lie in faulty operation of the digester.

Operating Records.—If sludge is pumped from the settling tanks to the digestion tanks a record of the hours of pumping and of the pump capacity should be kept; it is very desirable to know how much sludge, in gallons or cubic feet, is added to the digester daily. The temperature of the sludge in the digesters should be recorded daily, or at least weekly; also the pH of the sludge. The dates on which sludge is drawn should be recorded, and also the amount of sludge drawn, which can be determined approximately by the area of the sludge drying bed and the depth of the sludge on it. Frequently tests should be run to show the per cent of dry solids in the sludge as removed from the digester; other desirable information includes total solids and volatile solids in the digested sludge. A record of the daily gas production from the digester should be made from the gas meter; also of water temperatures in the heating water.

Scott suggests the following method of computing the sludge pumped: measure the stroke of the pump, the diameter and the revolutions per minute; or shut off the flow into a settling tank, and measure the dropdown with 5 or 10 minutes pumping.

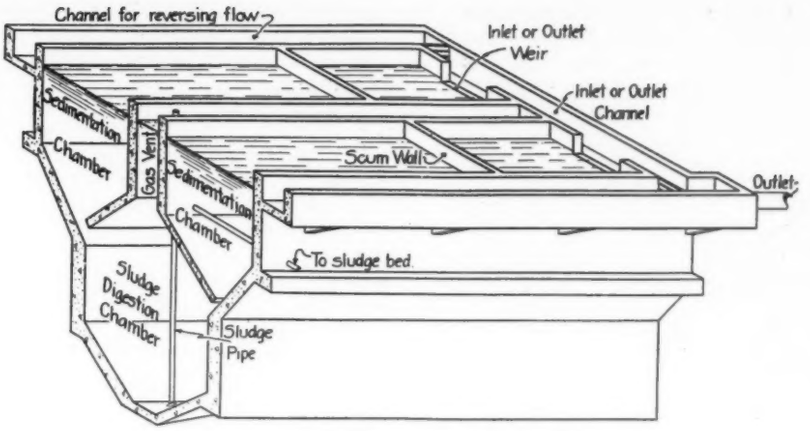


Fig. 15. Sectional view of Imhoff tank

Imhoff Tanks

The Imhoff tank acts both as a sedimentation tank and as a sludge digestion tank. It is, in effect, a two-story tank. The upper part is a settling tank; the lower stores and digests the solids that settle out of the sewage. These pass through a trapped slot in the bottom of the settling compartment and are retained in the sludge compartment until digestion has progressed far enough so that the sludge may be dried on sand beds. The sketch herewith (Fig. 15) illustrates the three important parts of an Imhoff tank—the settling compartment, the sludge compartment and the gas or scum vents.

The settling compartment is designed to provide a retention period of 1½ to 3 hours—usually about 2 hours. The sludge digestion compartment is usually designed with 2 to 3 cubic feet of capacity for each person it is expected to serve. The scum or gas vents should have an area of from 20% to 30% of the area of the tank surface.

General.—The inlet and outlet channels should be kept clean with a scrubber or squeegee and hose. Some Imhoff tanks are equipped with channels and gates for reversing the flow. These gates and channels should also be kept clean, and the flow should be reversed about twice a month. The heavier solids in sewage settle quickest. Therefore that part of the tank nearest the inlet receives most of the solids and may fill and require emptying before there has been time for digestion. Reversing the flow aids in getting equal deposits of sludge.

Sedimentation Compartments. — As already stated, this compartment should be large enough to give a detention period of at least 1½ hours. The operator can check this by measuring the width, length and depth and proceeding as already outlined.

Grease and scum should be skimmed off the surface daily. A skimmer suitable for the purpose is shown herewith, Fig. 16. The materials skimmed off may be placed in the gas vents, or burned or buried. The sides, ends and sloping bottoms of the sedimentation compartment should be scraped frequently — every day or every other day in warm weather and weekly or twice a week at other times. A squeegee is also shown in Fig. 16. The material that clings to the walls should be pushed down through the slot.

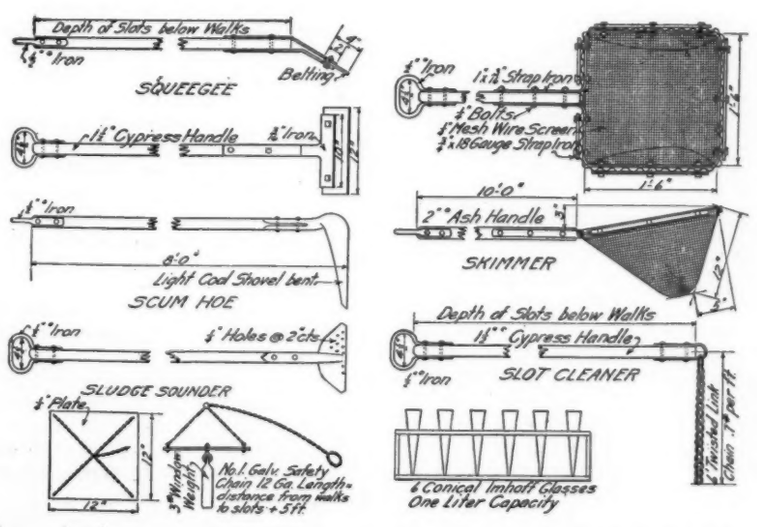


Fig. 16. Operators' tools for Imhoff tanks. Suggestions of Pacific Flush Tank Co.

The slot should also be kept clean. A chain drag is sometimes used for this purpose. The slot should be cleaned from one to three times a week.

In cleaning the walls and slot, unnecessary turbulence or stirring up should be avoided. The material in the sludge compartment should not be brought up into the settling compartment. The Imhoff tank is designed to keep the decomposing material in the lower chamber out of contact with the sewage in the settling chamber, as experience has shown that better settling and a fresher effluent easier to treat on trickling filters or contact or sand beds results from this separation.

Gas Vents and Scum Compartments. — Floating solids from the digestion chamber rise into these openings; also gas produced by the digestion of the sludge escapes through them. The scum may become very heavy at times. It is desirable that this floating material be broken up from time to time to permit the escape of gas and prevent the formation of solid masses of dry or partly dry material.

This breaking up of heavy material in the gas vents can be done with a rake or hoe; by using a fairly large hose under considerable pressure; or by pumping sewage from either the settling or sludge compartment with a small force pump. It is best to draw sewage from the upper part of the digestion chamber because this is returned through the gas vents and does not tend to cause flow between the upper and lower compartments. For the same reason, too much water should not be used.

The scum, if quite dry, may be removed with shovels and placed on the sludge drying bed for complete drying out.

Lime may be added; New York State recommends 10 pounds of hydrated lime per day per 1000 population. This can be applied as a solution and well mixed, or washed in well with a hose. The addition of lime also aids in maintaining an alkaline reaction, which is desirable for proper sludge digestion.

In cold weather, when the scum tends to freeze, holes may be punched through it to allow the gas to escape.

The Sludge Compartment. — The sludge digestion compartment is inacessible, as well as out of sight. Therefore operation must be based on pH and appearance of sludge and on soundings to determine the depth of the sludge deposit.

The pH of the sludge should generally be 7.2 to 7.6. An acid sludge may result in foaming, which is discussed hereafter. Well digested sludge is usually dark, rather granular and without disagreeable odor.

The depth of sludge may be determined: 1. By a pitcher pump with a weighted suction hose marked at 1- or 2-ft. intervals. Lower the hose through the gas vent or slot, working the pump handle. When thick sludge comes through the pump, or the pump chokes, as it usually will with thick sludge, the depth is determined; 2. A weighted wooden block, or iron plate 12 ins. square is lowered. Reduction in weight on the graduated chain or wire indicates depth. 3. A metal can or bottle, with a stopper and spring fastened to a rod; the stopper is pulled out with a wire.

Sludge should be drawn whenever it approaches within 18 ins. of the bottom of the slot or trap in the sedimentation chamber.

Drawing Sludge.—Sludge should be removed at a slow and regular rate; at comparatively frequent intervals; and not all the digested or ripe sludge should be removed. Usually not more than one-half of the depth of sludge should be removed at once; less is better.

Sludge in an Imhoff tank tends to become quite solid and firm, especially where there is much silt or sand in the sewage. If the attempt is made to draw sludge at a rapid rate, a hole may be formed that will draw undigested sludge or even sewage, while some of the digested sludge remains in the hopper.

Drawing of sludge is best accomplished by opening the draw-off valve part way, meantime pushing the sludge toward the bottom of the hopper with a long rod having a cross piece attached. A hose may be let down through the sludge pipe and water forced through to loosen the sludge. In summer, sludge normally will be drawn about once a month; in the winter only when the sludge in the tank reaches within 18 inches of the slots. After the sludge is drawn, the sludge piping should be flushed out with water and, where freezing is no hazard, the pipes should be left full of water to prevent sludge hardening in and clogging the pipes.

Foaming.—Gas vent contents sometimes become light and foamy and literally "boil over." This condition is called "foaming." It may be caused by industrial wastes from milk plants, canneries, breweries, etc., which turn sour in the tank; or it may be caused also by drawing too much sludge, by overloading the sludge chamber, by rapid increases in temperature of the sludge; or by other reasons.

If the cause can be determined it should be removed. If diagnosis of the trouble is not possible, various remedies may be tried, including: Putting the tank out of service temporarily, if another is available; drawing a small amount of sludge; adding lime through the gas vents; breaking up the foamy scum; prechlorination of the sewage, using three to ten ppm. of chlorine.

Operation Records.—The following records of Imhoff tank operation are desirable:

1. Settleable solids in raw sewage and in effluent, daily, by means of Imhoff cones.
2. Record of skimming sedimentation compartment.
3. Record of cleaning slots.
4. Record of breaking up scum.
5. pH of sludge (daily or weekly record).
6. Amounts of sludge drawn and dates of drawing.
7. Moisture and volatile contents of sludge.
8. Record of sounding for sludge depths.

Disposal of Sludge

The sludge that is drawn from a sludge digestion tank or from the sludge compartment of an Imhoff tank contains only a small percentage of solids — usually from 4% to 10%. The excessive amount of water must be removed. This is normally done on a sand bed, preferably covered with glass, or by means of special filters. (See page 63.)

If the moisture content of the sludge can be reduced from 92% or more to 65% or 75%, the sludge can be finally disposed of as fertilizer for parks, grass plots, farms, etc., piled in heaps, or burned in an incinerator. It should be noted that sludge with 5% solids and 95% water is six times as bulky for the same volume of solids as sludge containing 30% solids and 70% moisture. In the case of 98% moisture—which is about the average for sludge from digestion tanks—a reduction to 70% moisture means a reduction in volume to one-fifteenth the original volume.

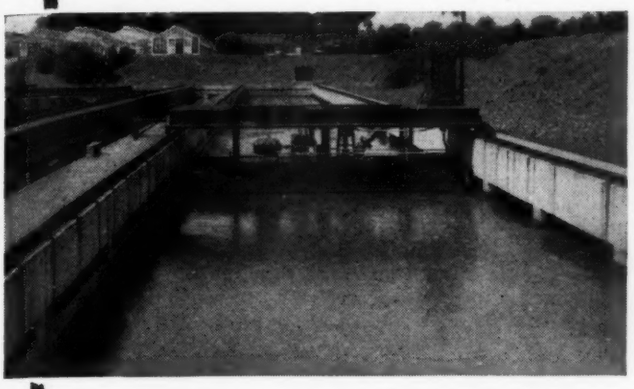
After proper digestion sludge has little, if any, disagreeable odor and when properly dewatered is unobjectionable. The removal of the excess water is necessary to facilitate final disposal.

Sludge Beds. A sludge drying bed consists of a layer of about 6 to 18 inches of sand, supported on 6 to 12 inches of graded gravel, under which are placed open joint drains. The water drains out of the sludge, and evaporates from it also—both actions being important. That part of the moisture which drains out passes down through the sand and gravel and into the underdrains which may discharge after chlorination into the outlet sewer from the plant; or better into a pump sump from which it is returned to the sedimentation tank. The latter procedure is preferable.

Sludge drying beds may be either open or covered. Structures similar to greenhouses are generally used for covering the beds. The open or uncovered beds should generally provide 1 square foot of area for each person served by the plant. That is, for 10,000 persons contributing to the sewers there should be at least 10,000 square feet. Covered beds need be only one-half as large, that is, one-half square foot per capita. The covered beds are more effective because they keep off rain and also the temperatures inside of them are normally higher, even when adequate ventilation is provided, as it always should be.

Depth of Drawing.—The depth to which wet sludge should be placed on the beds depends upon the condition or quality of the sludge primarily. The average depth in usual practice is 8 to 12 inches of wet sludge. With well digested, quick-drying sludge, greater depth is permissible. There is, in most plants, a critical depth at which best drying is accomplished, and the operator should learn this as soon as possible. If a 10-in. drawing will dry in 10 days, and a 12-in. drawing in 14 days, the former is best.

A well digested sludge is perhaps the most important item in sludge bed opera-



Cleveland, Ohio—Southerly Plant, *Capacity 30 M.G.D.* George B. Gascoigne Associates, Consulting Engineers. . . . 3 — 16' x 225' Automatic Magnetite Filters treat effluent from pre-activated trickling filters. . . . This installation replaces 3 — 75' square final humus tanks. The Magnetite Filters are built into the structure of these tanks.

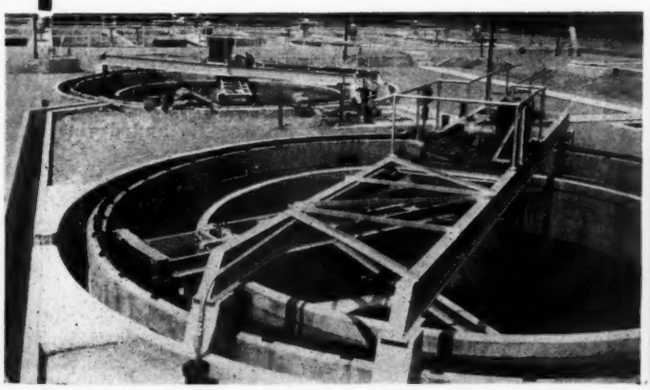
Buffalo, N. Y.—Plant *Capacity 150 M.G.D.* Greeley & Hansen, Consulting Engineers. . . . 3 Conkey Rotary Vacuum Filters each 11½' x 14' handle the sludge from this new plant among the largest in the country.

LARGE FILTERS FOR LARGE PLANTS

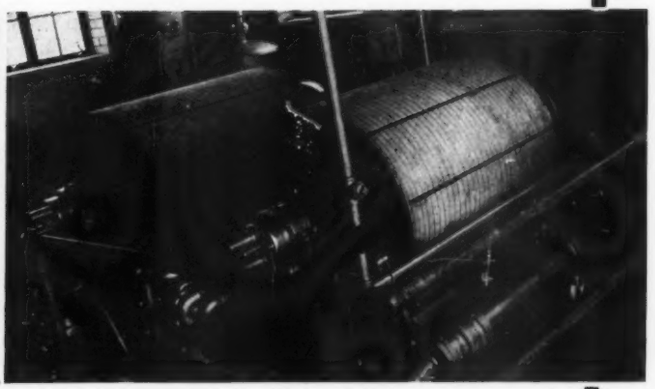
AND

SMALL FILTERS FOR SMALL PLANTS

Both Automatic Magnetite Filters and Conkey Rotary Vacuum Filters possess a flexibility of design that permits their economical use in treatment plants of every type and size.



Greece, N. Y.—Plant capacity *1 M.G.D.* Howard Thomas, Consulting Engineer. . . 2 Automatic Magnetite Filters *each* 4' wide on 35' diameter tanks clarify activated sludge effluent.



Lakeland, N. J.—Plant Capacity 0.25 M.G.D. Remington & Goff, Consulting Engineers. . . . 2 Conkey Vacuum Filters 3' x 4'. *This size is available for small communities in single or double units mounted on a common base.*

Our newly revised bulletin, now available, gives complete information concerning the design and use of Automatic Magnetite Filters in Sewage Plants.

FILTRATION EQUIPMENT CORP.

10 East 40th St. *Sales Office* **New York, N. Y.**

COARSE SCREENS • AUTOMATIC MAGNETITE FILTERS • CONKEY VACUUM FILTERS

When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 71-73

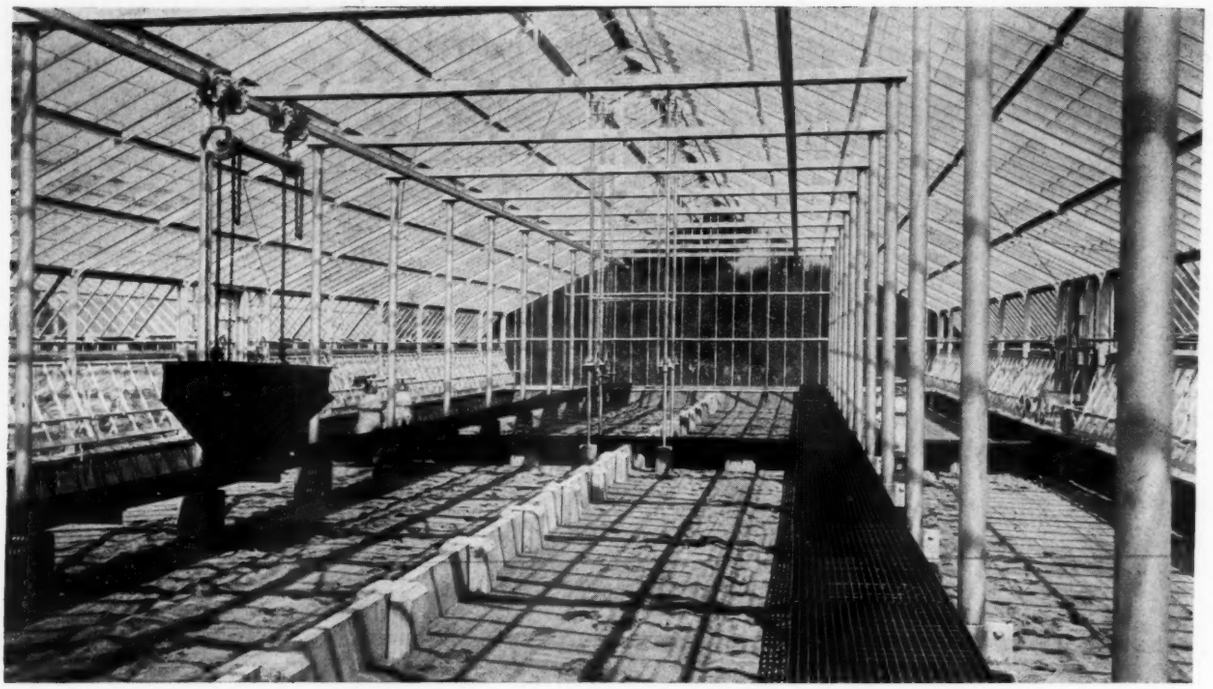


Fig. 17. Interior of a covered sludge drying bed

tion, so that control of digestion tank operation affects materially sludge bed operation.

Care of Beds.—After each layer of dried sludge has been removed, the bed should be raked and leveled. Some beds slope from the sludge discharge pipe to the far end. The amount of slope that is desirable varies with the character of the sludge. Imhoff tank sludge is often thicker than sludge from a digestion tank. For the latter a practically level bed is best.

Sludge should never be discharged on a bed containing dry or partially dried sludge. Such material should be removed before another application of sludge.

When large areas of beds are available, the sludge may be left until it is quite dry. In most plants excess area is not available and the sludge can be, and perhaps must be, removed as soon as it is dry enough to handle with a fork. It is preferable to remove the sludge at least two or three days before it is planned to apply more, to give the sand time to dry.

Removing Sludge From Beds. — A fork with 6 or more tines is generally used for removing the dried sludge from the surface of the beds. As little as possible of the sand should be removed with the sludge, but some will always stick to the sludge, so that there is a loss of sand with each layer of sludge removed. This requires eventual replacement of the sand. When the sand layer is reduced to 3 or 4 inches in thickness, more sand should be added. Occasionally the top layer of sand becomes clogged and interferes with drainage. When it is noted that a bed dries unusually slowly, the sand should be examined and if it appears to be clogged with organic matter, the top 2 or 3 inches should be removed and replaced with clean coarse sand.

Beds are provided with overhead rails or other devices for handling the sludge. On small beds, after the sludge near the door has been removed, a runway of planks can be placed on the sand and a light truck backed in on the bed. Sludge can then be loaded direct into the truck. To avoid breaking the underdrains, a double layer of planks, at right angles to each other can be used.

Disposing of Sludge. — Sludge has some fertilizer value and in some cases farmers will haul it away, but they will rarely pay for the sludge itself. In some cities, the park department uses the sludge on grass and shrubs. For such use, it generally should be ground, as the lumps in unground sludge take some time to break up. Some of the sludge produced can be used around the treatment plant for fertilizing grassy areas and shrubs. This is the best method of advertising both the value of the sludge and the quality of operation of the plant.

Using Chemicals.—Various chemicals have the property of expediting the drying of the sludge through improving its drainability. The ones principally used for this purpose are ferric chloride and aluminum sulphate. Ordinary applications are 5% or 6% by weight of the dry solids in the sludge. Computations for determining the amount of chemical needed are as follows: Assume a bed 20 ft. by 20 ft. to be covered with 12 inches of sludge having 2% solids and 98% water. Weight of sludge the same as water, or 8.3 pounds per gallon or 62.5 lbs. per cubic foot.

A bed 20 x 20 contains 400 sq. ft.; and when 12 ins. of sludge is drawn contains 400 cubic feet of sludge. At 62.5 pounds per cubic foot, this sludge weighs 25,000 pounds. If 2% of the sludge is solid matter, the weight of solid matter is 2% of 25,000 or 500 pounds. If 5% of the chemical is to be applied, the amount required would be 500 x .05 = 25 pounds.

The chemicals are usually added as a solution just as the sludge is flowing onto the bed, as the reaction is very rapid.

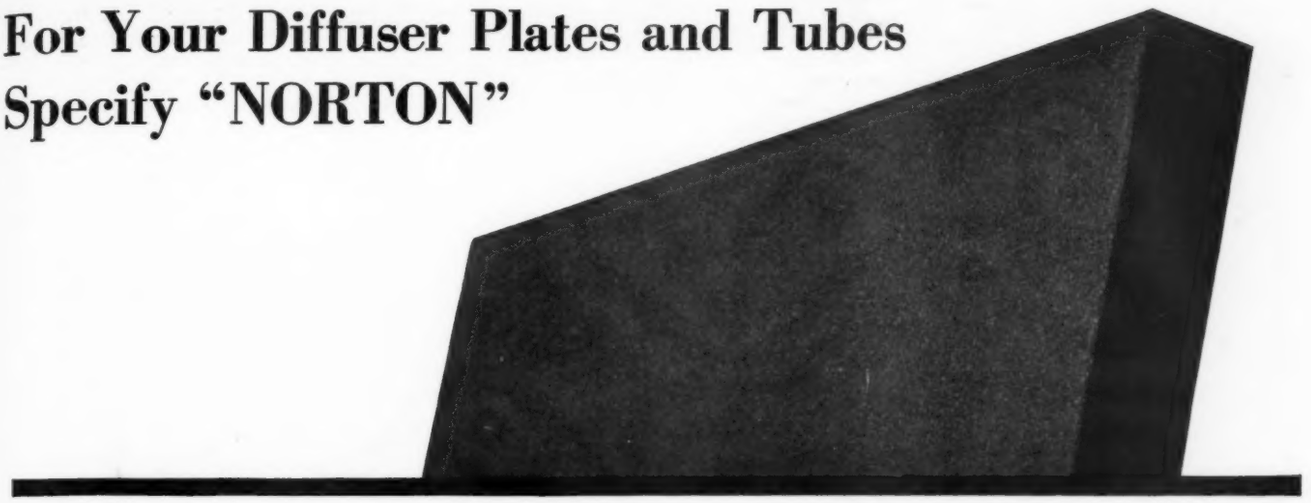
Winter Operation.—Open beds offer some difficulties in winter operation, particularly when heavy ice or snow storms, followed by freezing weather, occur when the sludge is partially dried. However, sludge may be placed on beds, particularly covered beds, in freezing weather. If frozen sludge can be removed without taking too much sand, and stockpiled, it will be found very desirable for use on lawns, after thawing and drying, as it tends to powder easily.

It is particularly important that all sludge lines, as well as any other lines carrying liquids, should be drained completely to prevent sludge from hardening in them, and also to prevent freezing in the winter.

Records of Operation.—At the time the sewage is drawn a record should be made of the date, the number or designation of the bed onto which the sludge is drawn, the depth of the wet sludge and the number of cubic feet drawn. When the sludge is removed from the bed, the date and number of the bed being cleaned should be shown, and also the depth of the dried sludge, the length of time it has dried, and the number of cubic feet or cubic yards removed. When the sludge is drawn to the beds, an examination to show the solids content, the volatile solids and the pH should be made. Likewise the moisture content of the dried sludge should be determined. All these factors should be noted on the records of operation.

Dewatering with vacuum filters and centrifuges is discussed on p. 63 of this issue.

For Your Diffuser Plates and Tubes Specify "NORTON"



WHEN you purchase diffuser plates or tubes for your plant you want to be sure they will give the longest possible life and operate as efficiently as possible. Norton experience in the manufacture of diffuser mediums covers fourteen years and has resulted in a product made of grains shaped to resist plugging and with a structure to deliver air in the most efficient manner for the operation involved.

NORTON COMPANY, WORCESTER, MASS.

R-586

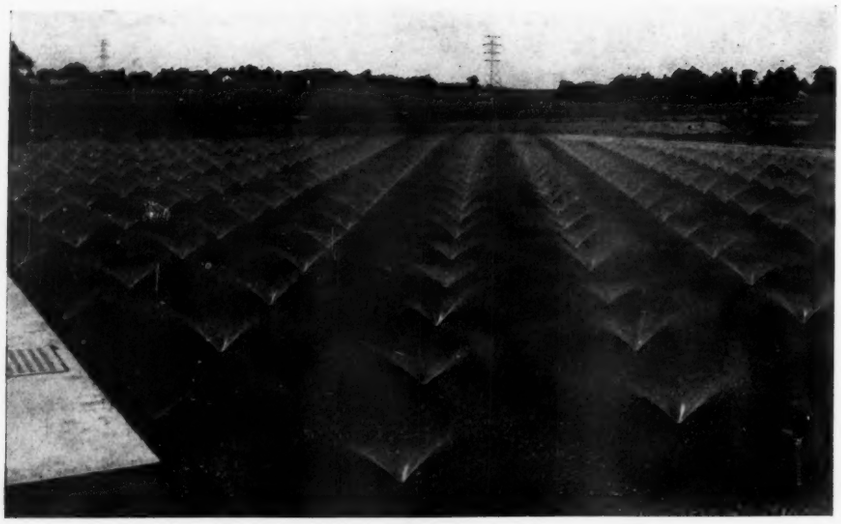


Fig. 18. Dosing trickling filters with spray nozzles (PFT)

Trickling Filter Operation

A trickling filter consists of a bed of 1½ to 3-inch broken stone, usually 6 to 8 feet in depth. The sewage is applied intermittently as a spray or in thin sheets to the surface of the bed, trickles down through the stone being collected by underdrains at the bottom. The filter is usually built with a concrete bottom and with stone or concrete walls to retain the broken stone. Application of the sewage is by spray nozzles or rotary distributors, which have been used on most recent installations. The rate of application is usually about 300,000 gallons per day per acre per foot of depth, based on average flow. That is, for a bed 6 feet deep, the rate per day per acre would be 300,000 x 6, or 1,800,000 gallons. This rate of application has been exceeded in some recent installations.

Only settled sewage, that is sewage that has been passed through an Imhoff or a settling tank, should be applied to trickling filters. Raw sewage, from which the solids have not been removed, will clog the stone beds.

The stone particles are, of course, too large to strain out the suspended matter in the sewage. Purification is effected by the organic film which forms on the surface of the stone. The sewage, applied in small amounts, trickles downward, the thin sheets of liquid passing over the organic film. This film contains aerobic bacteria which oxidize and stabilize the organic matter in the sewage. There is a considerable reduction in bacteria, in organic content and in BOD. However, the effluent from a trickling filter contains some bacteria, is therefore dangerous and requires careful disposal.

Methods of Applying.—The illustrations herewith show both of the usual methods of applying sewage to trickling filters.

Care of Nozzles and Orifices.—All clogged spray nozzles or orifices in revolving distributors should be cleaned as soon as clogging is noticed. Clogging is liable to be due principally to match sticks or other small solids, or to grease. To reduce trouble from the first cause, place a fine screen in the discharge channel of the sedimentation tank; to prevent trouble from grease, keep the dosing tank free from accumulations and deposits.

The Dosing Tank.—The dosing tank takes the flow from the Imhoff or settling tank, holds it temporarily, and then discharges it at a controlled rate through a siphon, to the nozzles or orifices onto the bed. The interior of the dosing tank has one or more sloping sides. In those places where spray nozzles are used, this insures that all portions of the area around each spray nozzle receives an equal dosage of the sewage. Thus, when the dosing tank is full and begins to discharge, there is a greater head and the nozzles spray over a wider area, but as the head becomes less in the dosing tank, the nozzles spray a less area. The tank is made smaller at the bottom therefore so that the smaller areas sprayed with the lesser heads will receive the same dosage per square foot.

A siphon controls the flow from the dosing tank. When the tank becomes empty, the siphon cuts off the flow to the nozzles, permitting the tank to fill again and repeat the cycle. Operation is controlled by air compressed under the bell of the siphon by the rising sewage.

Perhaps the most common difficulties in the operation of dosing tanks are due to air leaks in the control piping. This may result in the siphon discharging before the tank is filled, in which case only that portion of the filter nearest the nozzle is dosed. Or the tank may fail to fill, and a continuous small flow passes through it, too small to cause a spray from the nozzles.

Occasional cleaning of air and water lines is desirable, special precautions being taken with the connections of the air pipes to prevent leaks. Air leaks are difficult to locate, and in case of continued trouble from this source, it may be cheaper to replace all air piping with new lines.

Grease and other solids accumulate in dosing tanks and may cling to the sides, especially at the high water line. This material dislodges and may pass through the siphon and clog the nozzles. It should be removed regularly to prevent such accumulations.

Pooling or Ponding.—Pools or ponds sometimes form on the surface of the filter. This is usually due to organic growths or to retained organic matter from poorly settled sewage. Sometimes it is due to carelessness in dumping fine materials in one place when building the filter. When this is the cause, the fine material should be removed and replaced with suitable stone.

In most cases the trouble lies in the top layer of the stone, and forking or raking the stone to a depth of 8 or 12 inches or so is effective. Other methods include washing the surface of the bed with a heavy stream from a fire hose;

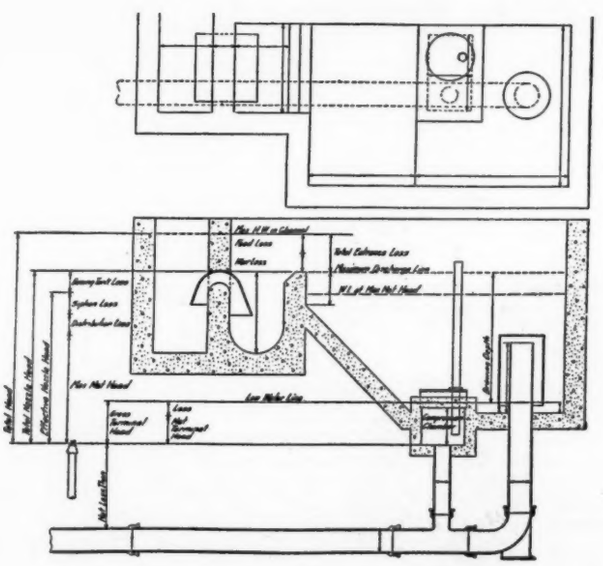
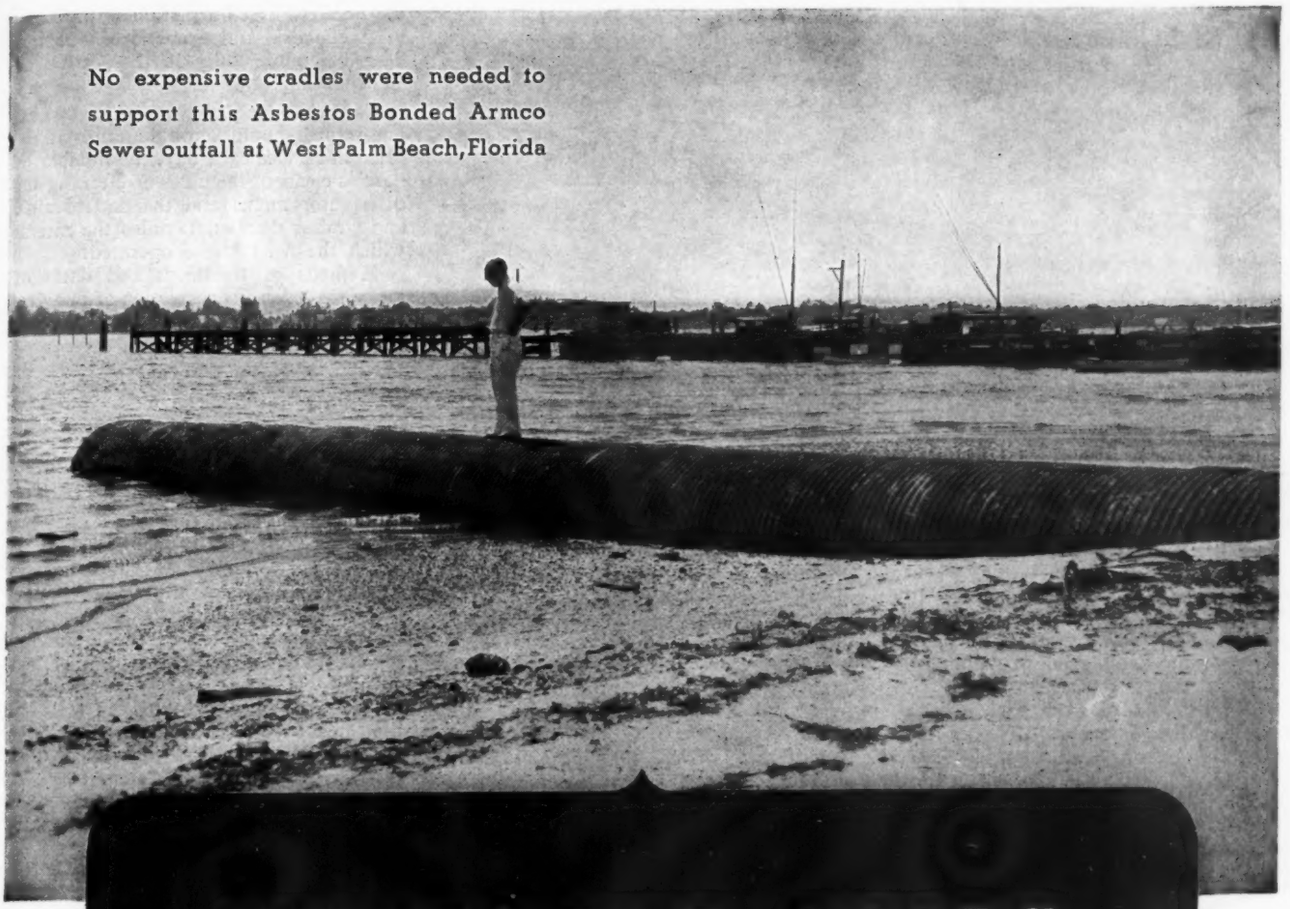


Fig. 19. Section and half plan of twin dosing tank for separate nozzle fields



UNSTABLE SOILS

won't disjoint an *Armco Sewer*

• Your "joint troubles" are over when you specify Asbestos Bonded Armco Pipe for sewers. Because of its flexibility, long lengths and sturdy connections, this improved pipe readily adjusts itself to soft, yielding foundations. No expensive piling or cradles are necessary to hold it in place.

Best of all, Asbestos Bonded Armco Sewer Pipe definitely solves your durability problem. Made of rust resisting ARMCO Ingot Iron, it boasts a *30-year background* in sanitary and combined sewer service. Then too, Asbestos Bonded Pipe is paved in the bottom and fully coated with a special bituminous material used successfully for 12 years. This bituminous material is "bonded" to the pipe in such a manner that it will stick indefinitely in handling and in service.

You'll find complete, useful data on this improved sewer pipe in the new 48-page Armco Sewer Book. A postal card or letter will bring your copy promptly and without obligation. Armco Culvert Mfrs. Assn., 703 Curtis St., Middletown, O.

ARMCO

Asbestos Bonded
ARMCO SEWER PIPE

A PRODUCT ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 71-73

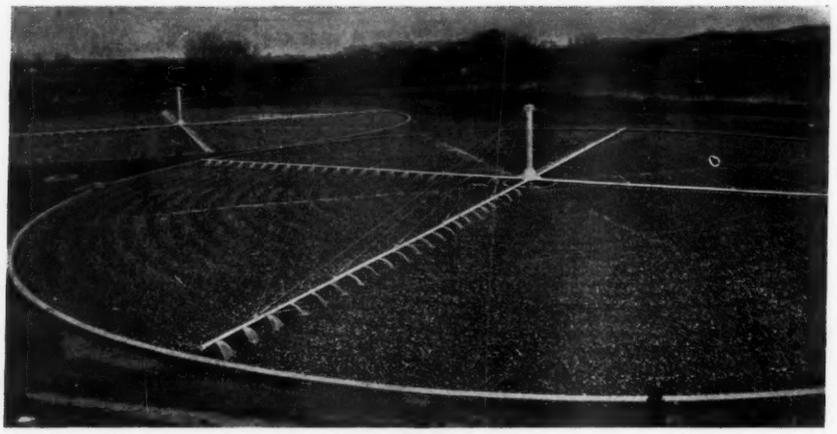


Fig. 20. Two Dorr Co. distributors at Rapid City, S. D.

taking the bed out of service for 24 to 48 hours, if this can be done without detriment to the quality of the effluent; flooding the bed for about the same period, if the bed is so constructed that it can be flooded; or by applying rather heavy dosage of chlorine to the sewage before it reaches the bed.

Application of 3 to 5 ppm. of chlorine has been found helpful; in some cases, dosages up to 10 ppm. have been used. Caustic soda has also given good results with dosage of about 10 ppm. When using chemicals, as chlorine, treatment may be given for 8-hour periods on alternate days.

Filter Flies.—The larvae of the filter fly *(Psychoda alternata)* may cause clogging or impair the efficiency of the filter. The adults may be present in such numbers as to be a nuisance at the plant and at houses within a quarter or half mile of the plant.

The flies lay their eggs in the filter film; the incubation or development period depends on the temperature, but is about 9 days. The larvae can be drowned by flooding the filter for a 24-hour period at intervals of 9 or 10 days. Chlorination, as directed in the preceding article, using 3 to 5 ppm. of chlorine is reported to be effective, if application is made every 7 to 10 days.

Adult flies can be killed by using any of the commercial fly or insect sprays, or by burning with a blow torch, but these methods are possible only after the nuisance has been produced. Prevention is far better.

Underdrains and Pipes.—In most plants there is an arrangement for inspecting the underdrain system; if this is not provided, an inspection of the flow from each of the underdrains is usually possible. The flow should be noted, and if clogging is indicated by reduced flow from any drain, this should be flushed out or cleaned with sewer rods. Underdrains should be flushed regularly, especially during first year or two of operation.

Also, in most plants each line of distribution piping is provided with a plug or valve so that the line can be flushed out. Where such provision has not been made, the spray nozzle at the end of each line can be removed during a dosing period. This will usually give sufficient velocity through the line to flush it out.

Winter Operation.—In systems with spray nozzles, the pipes carrying the sewage to the nozzles may freeze. A small bleeder tap, or a partly opened valve may be used to keep the distributor lines empty between doses. Such a tap or valve should be set in a small manhole.

In revolving distributors, the sewage enters through the central column. In extreme cold weather this portion of the distributor should be wrapped with burlap, or otherwise protected to prevent freezing. Or a tap may be placed to drain the column if there is an appreciable interval between dosages.

Odors and Prevention.—If the sewage is septic, spraying it into the air is effective in liberating the contained hydrogen sulphide gas, thereby causing odor. This occurs also, but not to the same extent, with the rotary type distributor.

Odors must be controlled by eliminating the causes before the sewage reaches the nozzles. Prechlorination is probably most effective and economical. This is described more fully in the section on chlorination.

Records of Operation.—The operating record should show the units of the filter in service each day, the number of nozzles cleaned, the dates of cleaning the distributor mains and the underdrains, and similar detail data; also the rate at which the filters were operated.

Methods of treatment and dates of measures taken for correction of ponding and for *psychoda* control, and for other unusual occurrences should be recorded in plant operation data.

Results of treatment are recorded by means of BOD tests on the influent and effluent. Or, where BOD tests are not made, results of methylene blue tests should be noted. Settleable solids in the filter effluent are also normally recorded by means of tests with Imhoff cones.

Secondary Settling. — From time to time, but most generally in the spring and fall, trickling filters "unload." The material accumulated in the interstices of the bed slough off and are washed out by the sewage. It is customary to provide a secondary settling tank for the effluent from the trickling filter bed; the usual period of detention is 1 to 1½ hours. Operation of this secondary settling tank does not differ materially from the operation of primary settling tanks.

Loading on Trickling Filters. — To check the loading on a trickling filter, determine the BOD of the sewage applied to the filter, in parts per million. The flow in million gallons per day times the BOD in ppm. times 8.33 gives the pounds in 5-day BOD applied per day. Divide this by the area of the filter in acres. This gives the loading per acre. A loading of 1800 to 2200 pounds per day is about normal.

Contact Beds and Sand Filters

Contact Beds

Contact beds, not now used in newer municipal plants, are composed of broken stone of about the same size and character as is used in trickling filters; but the stone is contained in a tight tank. Instead of trickling over the stone, as with the trickling filter, the sewage is held in contact with the stone for one or more hours, hence the name contact beds. The same type of organic film forms on the stone as in the case of trickling filters, and the same oxidizing action takes place. The rate of operation is lower than in trickling filters, being usually about 125,000 gallons per day per acre per foot of depth; average depth is around 3 feet.

The cycle of operation is approximately as follows: Filling the bed, the time depending upon the rate of flow of the sewage; standing full, from 1 hour or even less to 2 or 3 hours; emptying, 30 to 45 minutes, but depending upon the size and design of the bed; resting, 3 or 4 hours.

The resting period is most important, as it is during this time that the bacteria in the film on the stones reduces the organic material that has been deposited.

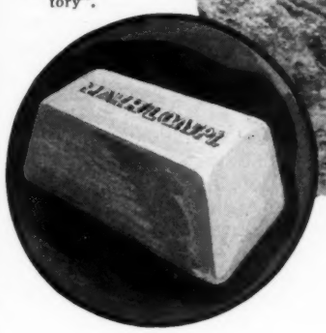
Control of operation is usually by air-locks and siphons. These fill the bed, divert the flow to another bed when the first bed is filled, regulate the period of standing empty; and, when the other beds have been dosed in rotation, once more fill the first bed. A typical layout is shown in Fig. 21.

Operation Factors.—The surface of the beds should be kept free from growths; the dosing apparatus should be inspected and timed daily to see that it is working properly and in order to determine the cycle of operation. Air leaks or clogged lines will interfere with the proper operation of the controls. Pipes should be kept clean, and joints and piping must be tight.

When new, contact beds have voids of about 40% or 45% of the capacity of the tank, and the bed will hold a volume of sewage equal to 40% or 45% of the tank capacity. With use, this ca-

"Nothing to Report...except.."

36" pipe, nine miles of it, laid in 1936 and 1937 at Lynchburg, Va. Jointed with Tegul-MINERALEAD. "Nothing to Report except that the City of Lynchburg has found the material Very Satisfactory".



. . . . that the Jointing of this NINE MILES x 36 Inches of Cast Iron Water Pipe at Lynchburg has proven VERY SATISFACTORY!

In this business of pipe laying, often the finest report the engineer can make is "Nothing to Report." That implies; No Trouble—No Leakage—No Service Interruptions . . . and isn't that just what *you* want when you lay Bell and Spigot Water Main?

And here is SOMETHING to report:

Many users of Tegul-MINERALEAD enthusiastically comment on its remarkable ease of handling, so the job moves along smoothly and swiftly and without need of skilled labor • That rainy days and sudden storms call for no care to keep this compound dry, for water runs off the Tegul-MINERALEAD ingot as easily as off the proverbial duck's back . . . something to think about when the compound is stored in the open • They also comment on the happy freedom from trouble due to change in composition—for Tegul-MINERALEAD reaches you exactly as we mix it at the plant. No amount of rough riding en route can shake down the heavier components in that 10 lb. ingot.

Tegul-MINERALEAD is a sulphur base compound. It seals practically at once, so joints meet any reasonable specification as to leakage. Streets can be restored to normal promptly — traffic hazards reduced. And joints are permanently tight and trouble-free.

• If you want the complete satisfaction implied by "Nothing to Report" long after the job is completed and in service, write for more information. Address:

The ATLAS MINERAL Products Company of Pennsylvania

Mertztown • Pennsylvania

Tegul-MINERALEAD

A Tegul PRODUCT

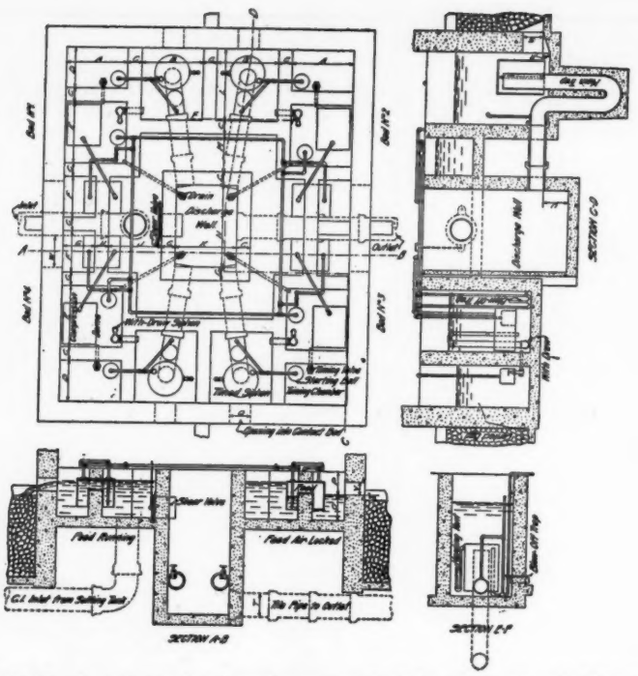


Fig. 21. Feeds and timed siphons for contact beds in a central control house

pacity decreases, and after a few years may be only half or even less of its original capacity. This is due to the solids that are deposited by the sewage in the bed.

When the capacity is considerably reduced, the stone can be washed and replaced, or the old stone can be removed and new stone put into the bed. In order that the capacity may be known, the time required to fill, and the rate of flow of sewage must be known. The capacity can then be computed.

Operation records should show the number of beds in service, the total number of fillings per day for each bed, and the quality of the bed effluent as determined by the BOD or methylene blue test. Such tests should be performed once or twice a week, in the smaller plants, and daily in larger installations.

Sand Beds

A sand filter consists of a bed of about 30 inches of sand, with underdrains, and with provision for applying the sewage to the surface.

The mechanical straining action of the sand removes some of the impurities from the sewage; and additional treatment results from an organic film on the surface of the sand grains. This organic film is of the same nature as that which forms on the surface of the stone in a trickling filter, and it operates in the same manner.

The rate of operation of a sand filter is about 75,000 to 100,000 gallons per acre per day, without regard to depth. Results of treatment are better than that obtained from either trickling filters or contact beds. But the large area of filters required for a city of even moderate size, and the possibility of odors arising from the beds make the use of this method of treatment unsuited for more than a few small communities.

Operation of Sand Filters.—Sewage is applied intermittently to the beds. An acre contains 43,560 square feet. The rate of application depends on the kind of sewage, as raw or settled. If the rate of operation is 87,000 gallons per day, the rate per square foot is 2 gallons per day. A cubic foot of water contains 7.5 gallons. Therefore, for a rate of 87,000 gallons per acre per day, the depth of sewage to be applied daily is $2 \div 7.5$, or 0.22 ft., or a little more than 2½ inches. This is applied at one time, and no more sewage applied for 24 hours. In some cases, a greater depth than 2½ inches is applied, with correspondingly longer rest periods; and some plants apply sewage continuously for 24 hours and then allow the bed to rest for several days.

The beds should be taken out of service at intervals and rested, allowed to dry and the surface raked or scraped clean to remove the surface mat that sometimes forms. The sand should not be plowed, harrowed or spaded over, as this tends to place the already clogged sand beneath the surface. The bed should be raked lightly as needed until there is some indication that the top surface is becoming clogged, when a thin layer should be removed—¼ to ½ inch.

The surface of the beds must be kept level, so that all portions will receive the same dosage, and vegetation should not be allowed to grow.

About once a year, the beds should be scraped thoroughly, and clean sand added to bring them to their original depth.

Winter Operation of Sand Beds.—For winter use, the beds are often ridged, that is, the sand is raked up into ridges about 1 foot high and 2 feet apart; or the sand can be raked into piles 6 to 12 inches high and about 2 or 3 feet apart each way. With the arrival of cold weather, the beds are filled to the tops of the ridges and ice is allowed to form. This ice is supported on the ridges or piles and forms a protecting cover which permits operation of the bed. Care should be taken that the ridges are so placed that all parts of the bed are accessible to the sewage.

As soon as danger from ice is past, the bed should be cleaned and leveled.

Operation Records.—Records should show the number of beds in service, with the rate of application; the number of beds cleaned and the amount of material removed; and the BOD or the putrescibility of the sand bed effluent by the methylene blue test.

Chemical Treatment

Certain chemicals are added to sewage to aid in the removal of suspended matter. These chemicals form a flocculent and gelatinous precipitate, which not only entraps the finer particles suspended in the sewage, but also expedites settling. In plain sedimentation only 50% to 60% of the suspended matter is removed by settling for 2 or 3 hours, and not much more with a longer period. By the use of chemicals practically all of the suspended materials can be removed.

In a well-designed and well operated plant, the BOD can be reduced about 75%, and the settling tank effluent can be made clear by the use of chemicals.

Chemicals Used.—The iron salts (Ferrisul, ferrous sulphate, chlorinated copperas and ferric chloride) and aluminum sulphate are employed in the chemical treatment of sewage as the coagulating agents; and lime to supply alkalinity or other factors required.

The choice between the coagulating agents mentioned depends upon the size of the plant, the character of the sewage and the cost of chemicals, which vary somewhat from place to place. Some chemicals react better with certain sewages, therefore tests are desirable in advance of selection. In large plants ferric chloride often has advantages, whereas in the smaller plants a chemical that is easy to store, handle and apply is desirable.

Ferrisul.—This is the trade name for a ferric sulphate that is prepared in a granular form for easy handling and feeding. It forms a floc over a wide pH range and is therefore unaffected by such changes as ordinarily occur in sewage. Enough alkaline materials are generally present in the sewage to react with the Ferrisul; if not lime must be added. The reaction with hydrated lime is:

$$\underset{\text{ferric sulphate}}{Fe_2(SO_4)_3} + \underset{\text{hydrated lime}}{3\,Ca(OH)_2} = \underset{\text{calcium sulphate}}{3\,Ca(SO_4)} + \underset{\text{ferric hydroxide}}{2\,Fe(OH)_3}$$

be 80 ppm. and that trials also be run at 100, 120 and 140 ppm. The reason for this is that tests are usually made in the forenoon or early afternoon when sewage is strongest and most difficult to coagulate, whereas from 5 P.M. to 9 A.M. a much smaller amount of chemical can be used.

A smaller dose—50 or 60 ppm.—may produce an effluent that is vastly better than that obtained without chemical treatment; but an adequate amount of chemical will, in most cases, produce a clear and sparkling effluent, almost equivalent in appearance to that from a sand filter. Such smaller dosages will often produce excellent results with the weaker night sewages.

Preparing Solutions for Laboratory Tests.—Solutions may be prepared by adding 10 grams of the chemical to one liter of water. One ml. of the resulting solution when added to one liter of sewage is equal to a dose of 10 ppm.

In certain cases, notably with lime in which the CaO or Ca $(OH)_2$ content varies, the resulting amounts of chemical required will be based on the characteristics of the particular sample used. This is not important, as a rule, for routine laboratory tests.

If it is desired to use quart jars instead of one-liter beakers, add 9.02 grams of chemical to one quart of water. One ml. of this solution added to one quart of sewage will give a dosage of 10 ppm.

Procedure in Testing Dosages.—To each of the jars containing one liter of sewage, add different dosages of the coagulating chemical. Assuming that the test is being made with aluminum sulphate, and that six jars are being used, proceed as follows, the necessary solution having been prepared and the jars properly filled with sewage:

Test the pH and record this; note hour sample was taken. Add to each jar the aluminum sulphate dose as follows:

Jar No.	*Dosage in ppm.*
1	70
2	80
3	90
4	100
5	110
6	120

After stirring for 10 to 15 minutes, allow the samples to stand. In general, in sewage treatment, the floc should form quickly and the floc particles should be large and settle quite rapidly.

Note the jar in which the best reaction occurs and try this dosage in the plant. If no satisfactory floc forms, and the pH is between 6.5 and 8.0, try a larger dosage of aluminum sulphate. Repeat the test with sewage from a sample collected during the night or early morning.

Repeat the test using Ferrisul, ferrous sulphate and ferric chloride, with the same dosages and with larger and smaller dosages. Control the pH if necessary, with lime to make it more alkaline, and with sulphuric acid to reduce the pH. A few tests will show how much of each is required. Dilute the acid with 50 or 100 parts of water to each part of acid.

Results of Chemical Treatment.—

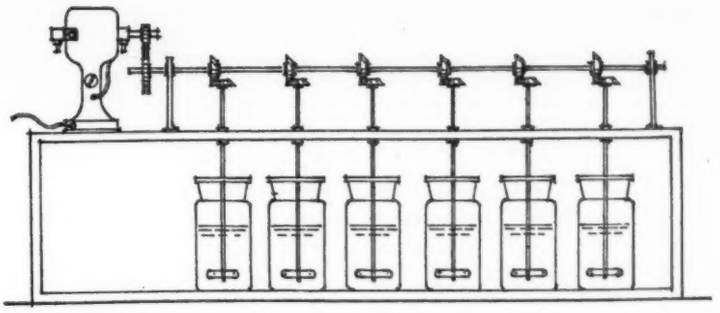


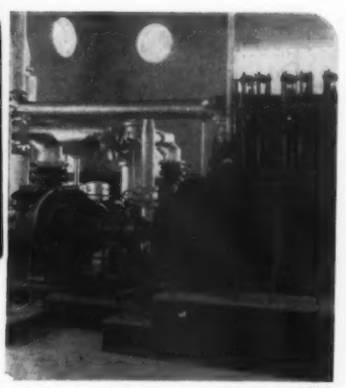
Fig. 22. A handy stirrer for laboratory use. (Courtesy National Lime Ass'n)

GET PERFECT JOINTS
by Using
WESTON
GASKETS and FORMS for all SEWER PIPE JOINTS
Minimizes infiltration, exfiltration.
Prevents root intrusion. Literature FREE
L. A. WESTON, ADAMS, MASS.

THE OPERATION OF WATER TREATMENT PLANTS
Copies of the April PUBLIC WORKS containing the outstanding instructional text for small and medium sized water works are still available. $1.—*and worth it a hundred times over!*
Book Dept., PUBLIC WORKS, 310 East 45th St., New York, N. Y.

STREET, SEWER AND WATER CASTINGS
Made from wear-resisting chilled iron in various styles, sizes and weights
MANHOLE COVERS, WATER METER COVERS, ADJUSTABLE CURB INLETS, GUTTER CROSSING PLATES, VALVE AND LAMPHOLE COVERS
Write for Catalog and Prices
SOUTH BEND FOUNDRY CO.
Gray Iron and Semi-Steel Castings
SOUTH BEND, IND.

AIR FOR AGITATION
POSITIVE DELIVERY
LOW COST OPERATION



These two 4,000 CFM gas engine driven "R-C" blowers in the Topeka, Kansas, sewage disposal plant supply air at 8½ lbs. pressure.

Gas engine driven Roots-Connersville Blowers totaling over 5,000 HP have been installed in modern activated sludge plants, making the most efficient use of the sludge gas and providing air supply at lowest possible cost.

Roots CONNERSVILLE BLOWER CORP.
CONNERSVILLE, INDIANA
TOMORROW'S ENGINEERING APPROVED BY YESTERDAY'S EXPERIENCE

When writing, we will appreciate your mentioning PUBLIC WORKS.

With adequate amounts of chemical in a properly designed and operated plant, turbidity can be entirely removed, in most cases during the entire 24 hours. The reduction in BOD will average about 75%; suspended solids are almost entirely removed; there is some reduction of dissolved solids and colloidal matter.

Essentials in Chemical Treatment.—First in importance is the selection of the proper chemical. Experience indicates that no one chemical is best for all sewages. Before finally selecting a chemical, several should be tried, each for an adequate period, to show its real worth. Aluminum sulphate, ferrisul and ferrous sulphate, in the small plant, and these and ferric chloride in the large plant, should be given a thorough trial.

Proper feeding equipment, proper mixing equipment, and a fairly adequate settling period are necessary for good results, even after the most suitable chemical has been selected. A reasonable amount of laboratory equipment and a place in which to do laboratory work are also necessary.

Experience emphasizes that a greater sludge digestion capacity is required with chemical precipitation than for plain sedimentation. The writer believes 3 cu. ft. per capita should be provided. Gas production is generally considerably greater per capita. A minimum settling period of 2 hours appears necessary, and more is probably desirable. Darby suggests the overflow rate should be 800 to 1000 gals. per sq. ft. of tank area per 24 hours.

Disinfection of Sewage

Chlorination of sewage is employed for a number of purposes: 1. To reduce the bacterial content of the plant effluent and thereby make it less of a nuisance and danger to bathing beaches, shellfish beds, etc.; 2. To control or prevent odors; 3. To aid in coagulation when ferrous sulphate or copperas is used as a coagulant; and, 4. To reduce the BOD of the sewage.

Bacterial Reduction.—While it is not possible to kill all the bacteria in sewage by chlorination, the number can be greatly reduced. This does not make water into which chlorinated sewage has been discharged safe to drink, but it does lighten the load on water purification processes.

The quantity of chlorine needed depends upon the strength of the sewage. For raw or untreated sewage, a fair application is about 20 ppm.; for settled sewage, 10 to 12 ppm.; and for the effluent from a trickling or sand filter, about 5 or 6 ppm.

The required amount of chlorine is best determined by the orthotolidine test which measures the amount of chlorine remaining after a contact period, of about 15 minutes.

Strength of sewage varies considerably throughout the day, being strongest, as a rule, after the middle of the forenoon. Dosages of chlorine should be adjusted for this period; an adjustment of the chlorine application can be made for the reduced and weaker night flows in many cases.

Odor Control.—As sewage decomposes, odors occur. The most common and important agent causing odors is hydrogen sulphide. Chlorine is used both to prevent its formation and to neutralize it after it has been formed. Control is more effective, as much less chlorine is required for prevention than for neutralization.

The most common method of prevention is to apply the chlorine in the main sewer as far as possible above the treatment plant. Chlorine acts on those organisms in the sewage which decompose the sulphur compounds, releasing the sulphur. From 3 to 30 ppm. of chlorine may be required; generally 8 to 10 ppm. will effect a marked reduction in odors. In some places odors are noticeable only during the evening. Under such conditions, chlorination may be needed for only a portion of the day.

After the sulphur is released, chlorine will combine with it to reduce or prevent odors, but the amount of chlorine required is considerable, and such procedure is very rarely if ever economical.

Odors from trickling filters have been reduced in some cases by 3 to 6 ppm. of chlorine.

BOD Reduction.—When sufficient chlorine is applied to sewage so that there is a residual of 0.2 to 0.5 ppm., there is a reduction in the 5-day BOD. This reduction depends to a considerable extent upon the characteristics of the sewage, but is estimated at from 15 to 25 per cent. That is, if a sample of sewage shows a BOD of 85, chlorination may be expected to effect a reduction to about 70, or perhaps lower. Each part per million of chlorine absorbed will reduce about 2 ppm. of oxygen demand. Apparently this reduction of BOD by chlorination is permanent.

Coagulation.—Chlorine is used with ferrous sulphate (copperas) in chemical treatment, to form chlorinated copperas, an effective coagulant. It is also used in connection with ferrous sulphate and lime to furnish the oxygen necessary to change the ferrous hydroxide to ferric hydroxide, the desired coagulant.

How Chlorine is Used.—Chlorine is employed primarily in the form of liquid chlorine, Cl.; and also in the smaller plants, as calcium hypochlorite. Liquid chlorine is 100% available chlorine. Actually it is a gas, but under pressure it becomes a liquid in which form it is shipped in steel cylinders. The pressure varies with the temperature from 40 to about 150 pounds, being greatest at high temperatures. At 70° F, it is about 85 pounds per sq. in. The cylinders used in small plants contain 100 or 150 pounds of chlorine, but larger containers are available.

Calcium hypochlorite solutions are prepared from commercial bleach, (also called bleaching powder, chloride of lime and chlorinated lime which is made by saturating quicklime with chlorine). Two types of calcium hypochlorite are available: The standard bleaching powder contains 25% to 35% of available chlorine and loses strength (that is, available chlorine) quite quickly when exposed to air. When stored in tight containers the chlorine content is lost more slowly, the rate of loss being around 1% a month. The other form available is more a stable form with a much greater chlorine content. HTH, or High Test Hypo, and Perchloron contain about 70% available chlorine.

Applying Liquid Chlorine.—Liquid chlorine is applied by means of a machine called a chlorinator, the function of which is to take the liquid chlorine from the cylinder, measure it, and feed it into the sewage at the desired rate. Application may be in either of two ways: As a gas, or mixed with water to form a solution, which is then added to the sewage.

The solution feed apparatus is used almost exclusively in sewage treatment. A supply of water under some pressure must be available for operating the machine, the amount of water depending upon the size of the chlorinator and the amount of chlorine fed.

Operation of a Chlorinator.—For proper operation, the room in which the chlorinator is kept should be over 50°F. Warm gas entering a colder chlorinator will condense and may cause clogging. Therefore, the chlorinator should not be placed on an outside wall, but should be in a warmer place than the cylinder or the pipe connecting the cylinder and the chlorinator. A radiator, a small stove, or an electric heater may be used. The chlorinator building should be insulated or well protected. When cold is not too intense, an electric light left burning, or a lighted lantern may furnish the required heat.

Chlorine cylinders should be kept on scales and the weight read each day as a check against the amount of chlorine used; or in the case of very small plants, the scales may be read weekly.

The maximum drawoff or discharge from 100 and 150 pound cylinders at 70°F. is approximately 35 pounds per 24 hours. Due to the change from a liquid to a gas, an excessive drop in temperature will occur and if more than 35 pounds are used daily, 2 or more cylinders should be attached.

A reserve supply of chlorine should be kept on hand; also a supply of duplicate parts, including valves, gaskets, etc. But the operator should not attempt major repairs. Whenever possible an entire duplicate chlorinator should be kept on hand for possible emergencies. Ask the manufacturer of your chlorinator for full directions for starting and stopping, and for other details regarding it.

Chlorine leaks are, of course, dangerous since the gas is irritant to the lungs and causes violent coughing. A concentration of 1 part of chlorine in 100,000 can be noticed; 1 part to 50,000 parts of air causes inconvenience; *and 1 part in 1000 of air after 5 minutes exposure produces death.* Leaks can be located by means of an open bottle of ammonia. Valves, connections and other places that may permit chlorine to escape are tested with the ammonia bottle. White fumes of ammonium chloride are formed when

chlorine combines with ammonia. Special gas masks are desirable to have on hand for use in case of leaks. Chlorine being heavier than air, ventilation at or near the floor level is desirable.

Metal parts on the chlorinator, or other metal surfaces, may become corroded. To prevent this, these may be painted with a thin coating of gasoline and vaseline. The gasoline evaporates and leaves a light coat of vaseline which is sufficient protection.

Chlorination with Bleaching Powder.—Since effective chlorination cannot be obtained by feeding the dry powder, a solution must be made and fed into the sewage. There are several excellent feeders for this purpose. Because conditions of use for hypochlorite solutions differ so materially, the advice of the State Sanitary Engineer should be sought regarding their installation.

It is easier to feed a weak solution using larger quantities, than to apply small amounts of a concentrated solution. For example, to make a solution containing ½% of available chlorine, using 100 gallons of water, which weighs 834 pounds: Chlorine required is ½% of 834 = 4.17 pounds. If the bleach has a chlorine content of 25%, which is about the average, 4.17 x 4 = 16.68 pounds of bleach will be needed for 100 gallons of solution.

When HTH or Perchloron are used, with a 70% available chlorine strength, 4.17 ÷ 0.7 = 6 pounds of chemical will be needed per 100 gallons of water.

Hypochlorite solution may be purchased ready for use; but it is usually cheaper to make it up. To do this, a mixing tank, with motor driven paddles is desirable. The bleach is added to the water, or preferably made into a paste and added. After mixing 15 to 30 minutes, the solution should be allowed to stand for an hour to permit the particles of lime to settle.

Solutions lose strength on standing even in dark, cool places, and therefore should be used promptly.

Computing Dosages.—When using liquid chlorine, the desired dosage in parts per million times the number of million gallons per day times 8.33 is the number of pounds of chlorine to be fed daily. For instance, to treat 2 mgd. with 6 ppm. of chlorine, 6 x 2 x 8.33 = 100 pounds per day.

If it is desired to vary the amount of chlorine hourly, the number of gallons per hour times the dosage in parts per million times 8.33 indicates the number of pounds per hour. For example, with a dosage of 8 ppm., and a flow of 300,000 gallons per hour, there will be required per hour, 8 x 0.3 x 8.33 = 20 pounds.

Most chlorinator scales read in pounds per 24 hours. For the proper setting, multiply the hourly rate by 24. In the above case, the rate in pounds per 24 hours would be 20 x 24 = 480 pounds.

Dosages with Bleach.—To chlorinate 70,000 gallons of sewage per day using a dosage of 5 ppm., with HTH or Perchloron: 70,000 gallons of sewage weighs 583,000 pounds or .583 million pounds. With a dosage of 5 ppm., the amount of chlorine required is .583 x 5 = 2.9 lbs. The HTH or Perchloron has 70% available chlorine, and the amount required is 2.9 ÷ 0.7 = 4.2 lbs. If a solution with a 1% strength is to be used, there will be required 2.9 x 100 = 290 pounds of water, or about 35 gallons, into which the 4.2 lbs. of chemical should be mixed.

Records of Operation.—The records covering the application of chlorine should show (1) the volume of sewage chlorinated daily; (2) the rate of application of the chlorine; (3) the residual chlorine present which, if taken daily should be at the same hour every day; (4) the weight each day, at the same hour, of the chlorine tanks; and (5), new cylinders placed on the scales and their weight.

Sludge Dewatering

Vacuum Filters.—Vacuum filters are used for rapid dewatering of sludges. They are suitable for either raw or digested sludges removed by primary or secondary treatment plants. Sludges containing 85 to 98% moisture are rapidly dewatered, producing a filter cake of 65 to 75% moisture. There are two makes of rotary vacuum filters which have general acceptance for dewatering sewage sludges, the Conkey rotary vacuum filter made by Filtration Equipment Corporation and the Oliver filter made by the Oliver United Filters, Inc.

Just Published

WATER SUPPLY AND PURIFICATION

By W. A. Hardenbergh, Asso. Editor PUBLIC WORKS

Designed especially for the practicing engineer who needs to have available the details necessary in designing a water system and treatment plant. Flow in pipes; consumption data, per hour, day and month; rainfall and runoff; design of supply lines; flow through a distribution system; constructing a water works system; illustrative examples covering these points are worked out in detail to act as bases for solving the problems the engineer will actually meet.

Methods of treatment; requirements of quality in regards to bacterial and mineral content; laboratory tests and their interpretation; settling basins; coagulation and chemical treatment; filters and their design; chlorination; softening; iron removal, etc. Illustrative design of small treatment plant. About 400 pages. Money back in 10 days if not entirely satisfied.

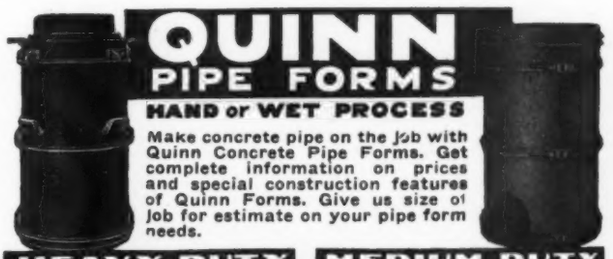
USE THIS COUPON

Book Dept. PUBLIC WORKS, 310 East 45th St., New York, N. Y. Enclosed find $3.75 for which send me WATER SUPPLY AND PURIFICATION by Hardenbergh. If not satisfied I may return book in 10 days and you will refund my money in full. 9-38

Name..... Title.....

Street.....

City..... State.....



QUINN PIPE FORMS

HAND or WET PROCESS

Make concrete pipe on the job with Quinn Concrete Pipe Forms. Get complete information on prices and special construction features of Quinn Forms. Give us size of job for estimate on your pipe form needs.

HEAVY DUTY

Built for more years of service—sizes for any diameter pipe from 12 to 84 inches—any length—tongue and groove or bell end.

MEDIUM DUTY

Makes same sizes pipe as "Heavy Duty" but built to meet demand for lower cost equipment to produce uniform quality in smaller amounts.

Also manufacturers of concrete pipe machines for making pipe by machine process.

QUINN WIRE & IRON WORKS 1621 12 St. Boone, Iowa

HEAVY-DUTY INCINERATION

MORSE BOULGER DESTRUCTORS

for the

INCINERATION OF MUNICIPAL WASTES

Garbage, Rubbish, Sewage Screenings and Sludge

For complete information call or write

MORSE BOULGER DESTRUCTOR COMPANY

HOME OFFICE: 202-P East 44th St., New York, N. Y

A vacuum filter installation consists of sludge pump or bucket elevator, chemical feeders, sludge conditioning tanks, vacuum filter, vacuum receiving tanks, moisture trap, dry vacuum pump, filtrate pump, blower, filter cake conveyor and sludge cake hopper. Filtering is accomplished through a cloth medium on a drum rotating in a container of sludge. The filter cake is taken off by means of a scraper onto a conveyor.

Conditioning chemicals are required to prepare the sludge for dehydration. These are ferric chloride and lime, or ferric chloride alone, depending on the characteristics of the sludge to be dewatered. Fresh settled and chemically precipitated sludges are best conditioned with lime and ferric chloride. Activated sludge and elutriated digested sludges are usually conditioned with ferric chloride alone. Digested sludges may be conditioned either with ferric chloride alone or with ferric chloride and lime.

When sludge is properly conditioned, yields of 5 to 8 pounds of dry solids per sq. ft. of filter per hour are obtained dewatering plain settled and chemically precipitated sludges, in either raw or digested condition. Chemical conditioner required for most efficient and economical operation for such sludges amounts to an average 2% ferric chloride and 10% lime, figured as a percentage of the dry solids in the sludge. Moisture of vacuum filter cake will average from 65 to 70%. Activated sludge mixed with plain settled sludge requires about 5% ferric chloride and yields about 3 lbs. dry solids per sq. ft. per hour. Activated sludge alone yields about 1 lb. of dry solids per sq. ft. per hour, and the cake has a moisture content of 80 to 85%. In each case the operator must determine by trial the chemical dose most suited to the sludge with which he is working.

Whereas, sand drying beds require about ½ to 2 sq. ft. per capita, 1 sq. ft. of vacuum filter area is suitable for a population of 160 for raw activated to 1,280 people for primary digested sludge. Other types of sludge come in between these figures.

Vacuum filters are usually operated during the day shift, with 6 hours actual operation, and one hour for starting and one hour for washing up. Where vacuum filters precede incinerators, their operation must be coordinated to meet the requirements of the incinerator.

In order to obtain a satisfactory cake, it is necessary that the sludge be properly conditioned, otherwise the filter cloth will blind and the yield of cake will be very poor. In order to be sure that the sludge is properly conditioned, it is better when starting filtration to increase the chemical dose about 50% above the normal for about a half hour and then gradually reduce the dose to a normal amount, until just the right cake is being obtained. When the proper chemical dose is obtained, the cake will be discharged cleanly from the cloth without sticking.

The filter cloth should be washed with water, after each day's run, by turning on the water sprays and opening the drain valves. When the cloth has become blinded, it is more economical to install a new cloth, than to operate with a dirty one. Under normal conditions, cloths can be operated for 6 to 10 weeks without changing. It is also important that the grease cups and oil wells be checked at least once a day.

For alkaline conditioning, that is, where lime and ferric chloride is used, cotton cloths are suitable, whereas if ferric chloride alone is used for conditioning, it is necessary to have a woolen cloth. The filter must be designed to resist ferric chloride, where this type of conditioning is used, and the manufacturer will recommend the correct type of construction of the filter for the use indicated.

Before starting operation of a vacuum filter installation, the operator should obtain full instructions on chemical dosages and mechanical operation and care, from the filter manufacturer.

Centrifugal Dewatering. — Centrifugal machines are used as an alternative for sludge drying beds. Advantages to be gained by using centrifugal machines are, according to the American Centrifugal Corporation, as follows: Saving in land area costs and expensive drainage installations; saving in time of drying, as centrifuging is done the same day sludges are cencentrated; no offensive odors, thereby eliminating complaints of neighboring property owners; sludges containing from 90-95% moisture are reduced to 70-50% moisture, depending upon the types and kinds of sludges; costs of operation are less than where drying beds are used; conditioning chemicals are not required; and when necessary, grease can readily be separated from sludges by centrifuging.

Preaeration

Preaeration accomplishes several objectives. It was primarily developed for separation of grease from sewage for subsequent skimming from sedimentation tanks. It also prevents odors by keeping the sewage fresh. A third and perhaps most important function is improvement of sedimentation. This is due to a flocculation of solids which usually increases the efficiency of sedimentation at least 25% in removal of suspended solids.

The preaeration tank is usually a plain rectangular plan tank about 12 to 14 ft. deep and slightly wider with a retention period of 5 to 15 minutes. Greater retention periods are used on the smaller plants to avoid short circuiting. Diffusers may be installed along one side, along the center line or in several rows transverse to the tank center-line. In all cases, they are installed at the tank bottom to give maximum "sweeping" action of the air through the sewage.

Normally about .05 cu. ft. of air per gallon of sewage treated is required. This should be provided by rotary positive displacement blowers with an air filter on the intake. The entire equipment required will usually run less than $300 per m.g.d. capacity.

General Factors

Safety in the Sewage Plant.—Some of the precautions to be taken in regard to liquid chlorine have already been mentioned. Gas poisoning and gas explosions are other hazards. The gas produced by sludge digesters is explosive when mixed with at least 5 times, but not more than 19 times, the volume of air. Therefore smoking or carrying open flames in or around digesters is hazardous. In pump pits or other covered and enclosed places similarly explosive gas often gathers and precautions are necessary in entering them to prevent explosions. Also, the gases contained may be fatal to anyone who breathes them. Therefore, covered tanks or pits should be well ventilated by blowing air through them before being entered; anyone entering them should fasten a rope to his body, and an assistant should remain outside holding the other end of the rope and ready to help.

A gas mask should be a part of the equipment of every plant. Be sure to note if this mask protects against chlorine and against carbon monoxide also. Individual gas masks are serviceable for protection against only a few gases. Therefore a mask designed to serve against ammonia may be of no use whatever against chlorine.

It is desirable to protect tanks by railings to prevent attendants or visitors from falling into them. Gears and other moving parts should be screened or guarded.

An excellent article on safety in the sewage treatment plant was published in the August issue of PUBLIC WORKS.

General.—Keep a set of the blueprints showing details of the plant. Some of these may be framed and hung on the walls, not so much for decoration as for ready reference and preservation. Prints handled frequently rapidly wear out. Pumping installation, pipe layouts, and similar material that is needed for more or less frequent reference can be kept under glass.

Keep your own copy of your monthly reports to the State Department of Health, and study them from time to time. Familiarity with what has been done and the results obtained is of most value in efficient operation. Written records are best, as memory is sometimes unreliable. Experiments should be written up in a note book, whether results are favorable or unfavorable; also unusual events in operation. A loose-leaf book is desirable but not necessary.

A' library should be maintained at every plant. This should include Standard Methods and at least a couple of recent texts on sewage treatment; also some of the many excellent bulletins and pamphlets issued by manufacturers serving this field. Read your technical magazines; the Digestion Tank section of PUBLIC WORKS will keep you informed on what has been published. Join your Sewage Works Association, or at least attend its meetings. Enroll for some of the short courses now being given in almost every state. And if you need help, write the Editor of PUBLIC WORKS.

Keeping Up With New Equipment

Salt Tablets and Dispenser

Medical authorities say that anyone who works on a "hot job," anyone who exercises violently in hot weather or sweats profusely, should take Salt Tablets to replace salt lost by the human system in perspiration and prevent "heat sickness." For some time International Salt Company, Inc. has furnished such tablets to industry. This company has now developed an attractive and convenient moulded plastic dispenser which makes it possible to distribute tablets at all drinking water locations where workers would use them.

Consumption of the salt tablets helps men on hot jobs to keep the amount of salt in the blood at the proper proportion all the time. Science has discovered that it is not possible to keep up the salt balance in the normal body with salt added to food alone when exercise is violent or work hard. Experience shows that workmen in "hot jobs" who take a 10-grain salt tablet with every drink of water do not get heat cramps from "heat sickness."

Making a Bridge Safer for Pedestrians

Down in Chattanooga, Tenn., the Walnut St. bridge has been equipped with a low guard rail to keep automobiles off the walks; but this also serves to keep the automobiles out of trouble, as it deflects them back into the roadway. This guard rail is bolted fast to a guard timber as shown. It consists merely of a Tuthill guard of spring steel, such as is used for highway guard rails. Looks like a mighty good idea.

White Suction Screen

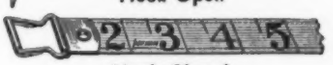
Suction Screens

White pump strainers are made by threading wire through bars, as shown in the illustration herewith, producing a strong screen. These are made in many types and sizes, including the taper type screen shown, basket screens, etc. Screens can be made of any material to resist corrosion, as steel, cadium plated or galvanized; brass; bronze; stainless steel, etc. Fuller information in Bulletin 25, which will be sent on request. White Machine Works, P. O. Box 270, Fort Wayne, Ind.

Hook-Ring for Woven Tapes

A folding end hook of new pattern for Woven Tapes is made by the Lufkin Rule Co., Saginaw, Michigan, and New York City. It enables one man to take many measurements unassisted. It will hold tape at end of a board or pipe, corner of a building, and hundreds of other places, yet readily folds flat against the tape ring, out of the way, in no way hindering use of tape without hook, and

Hook Open

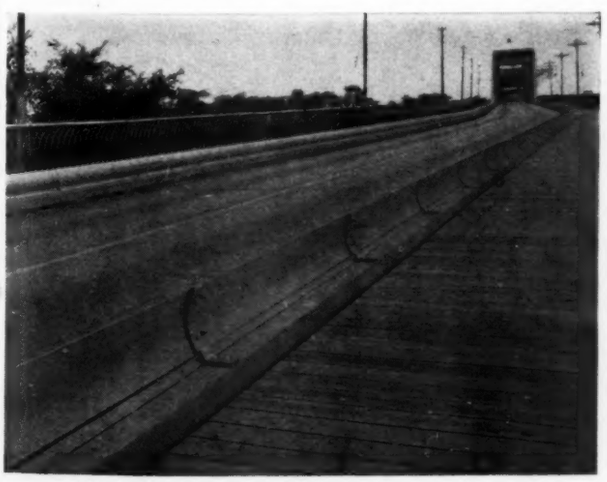


Hook Closed

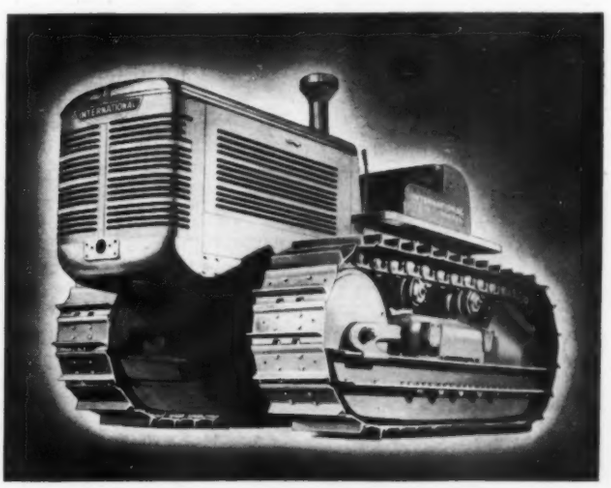
it will not catch objects or prevent tape line being fully wound into the case. Friction holds hook in position when open and closed. Zero falls at inside of open hook.

International TD-18 Tractor Is New

The International Harvester Co., 180 North Michigan Ave., Chicago, Ill., have just announced a 6-cylinder, 70-hp. diesel tractor. It has a 6-speed transmission, weighs about 21,000 pounds, and will travel up to 5.62 mph. All controls and gauges are within easy reach of the operator, who is provided with a comfortable seat and has good vision to front, sides and rear. This tractor has been under development for the past four years, during which time it has been tried out on many types of heavy work. The crawler treads have a contact with the ground of more than 84 ins., providing ample traction. Complete information from International on request.



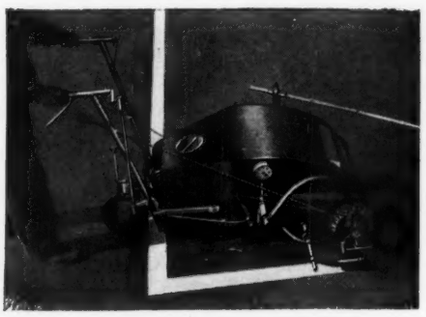
Tuthill guard rail on bridge



The new International Tractor

A Streamlined Street Marker

This is a one-man operated, power driven, balloon-tired spray marker for lining streets, parking places, etc. It



Meili-Blumberg marker

will handle any kind of paint, or hot asphalt. Before the paint is applied, the exhaust from the engine is used to blow dust and dirt off the street. Paint is then sprayed on the surface and finished off with a brush. The spray gun can be detached and used to paint curbs, guard rails, bridges, fences, etc. A rod and chain projects out as a marking guide. Nice catalog from Meili-Blumberg Corp., New Holstein, Wis.

Everson Automatic Vacuum Controlled Chlorine Sterilizer

A new "automatic vacuum controlled" chlorine sterilizer for water works and sewage is announced by Everson Mfg. Co., Chicago, Ill. This measures and feeds chlorine gas as a solution, and is safe and accurate under both usual and unusual conditions. Described as a Rotameter (Rota-relay for large capacities) Automatic Gas Shut-Off Vacuum Sterilizer, it has: Accurate, visible control of gas flow; capacity ratios from 1½ to 65; 2 moving parts only; single valve control; automatic gas shut-off if water pressure fails; electrical synchronizer for "on" and "off" of sterilizer with pump; complete vacuum feed; separation of water and gas lines; water sealed gas vent with siphon break preventing backflooding; operates with low water pressure; parts accessible and non-corrosive —rubber, glass, silver or tantalum where needed; standard SAE threads and parts. In modern enameled designs; self-contained, with only Rota-meter, single valve control and connecting lines outside of cabinet walls.

Streamlined GMC trucks speed sanitary refuse disposal in San Francisco.

New Swing Diffuser

Diffused air equipment that can be raised out of the aeration tank without interrupting operation or dewatering the tank is announced by the Sewage Equipment Division of the Chicago Pump Company. The new equipment is called "swing diffuser." It is composed of an assembly of streamlined diffuser tubes suspended from a swing joint. The tube assembly can be raised to the tank walk by a portable electric hoist.

The accessibility of the diffuser tubes from the tank walk makes it a simple matter to space the tubes to regulate the air supply in accordance with the tapered aeration principle. This gives controlled aeration for the activated sludge process.

Power economy effected by swing diffusers is pointed out as follows: 1. Shorter aeration periods and less air with tapered aeration; 2. higher aeration efficiency of swing diffuser units requires less air for optimum tank circulation and oxygenation; 3. "new" porosity of aeration tubes simply maintained; and, 4. suspension of diffuser tubes lessens hydrostatic head.

This equipment, the manufacturer states, makes it economically feasible for cities smaller than 10,000 population to obtain the advantages of diffused air in activated sludge plants operating on the tapered aeration principle. This is of special importance for cities having abnormal sewage strengths, including industrial wastes. In these cases the relatively great quantities of oxygen required for an economical aeration period can be supplied by swing diffusers to provide operating economy.

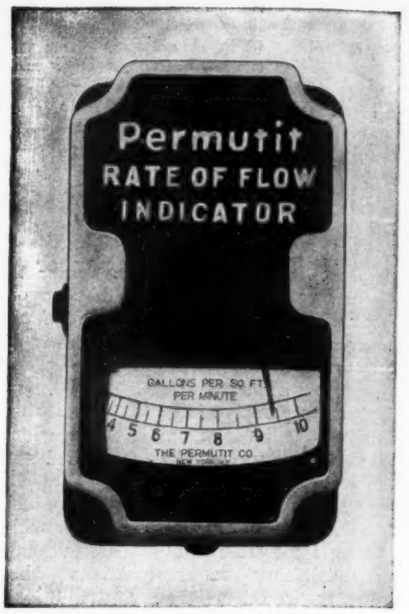
A copy of the Swing Diffuser Bulletin 175 will be sent upon request to the Sewage Equipment Division, Chicago Pump Company, 2338 Wolfram Street, Chicago.

Prints in 2 Minutes 10 Seconds

The new Bruning Model 4 Black and White printer will produce prints in short order. Two pieces of equipment are needed, the printer and the Model 149 BW developer. It takes 2 minutes to expose the print and 10 seconds to develop it. No plumbing, no special wiring, no tanks, no wet prints, no drying, no special room, and no experience. Sold or rented. Will take prints up to 42 inches wide. Full data from Chas. Bruning Co., Inc., 100 Reade St., N. Y., and 12 other cities.

Chicago Buys 2000 Fire Hydrants

Koppers Company, Western Gas Division, has received a contract from the city of Chicago for 2,000 fire hydrants to cost approximately $90,000. They will be built according to the city's own standard specifications. This is the third order to be received his year by Koppers Company for Chicago public works equipment. Orders for 2,100 fire hydrants and 30 24-inch and 10 36-inch gate valves were received last May.



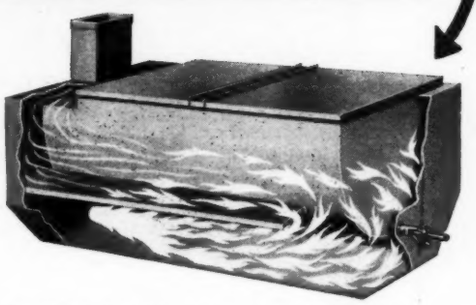
Rate of Flow Indicator

Permutit Co., 330 West 42nd St., N. Y., have brought out a rate of flow indicator that shows the operator of a filtration or softening plant the rate of operation, thus permitting him to avoid over or underloading of the various units. The manufacturers say that this is not affected by dirt in the water, is easy to read, and has no moving parts. A bulletin describing the indicator and its uses will be sent on request.

Errata-Manual of Street and Highway Equipment and Materials: The Municipal Street Sign Co., Brooklyn, N. Y., should be included among the makers of flashing and reflector signals, sign posts for street signs, and stop and warning signs. The first two are illustrated above.

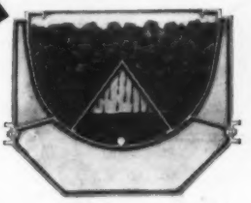
2 REASONS WHY LITTLEFORD 84-HD KETTLE HEATS FASTER

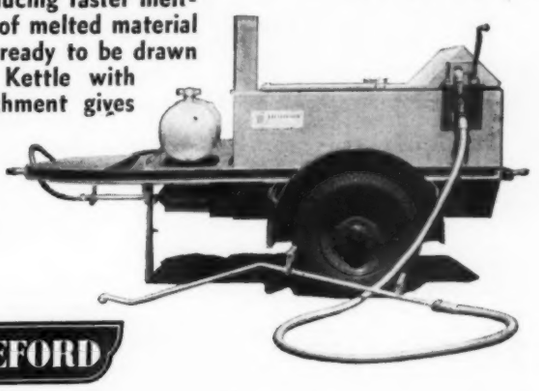
1 DOUBLE HEAT CIRCULATION
2 SCREENED RESERVOIR



The Littleford 84-HD "Double Heat Circulation" system provides uniform temperature throughout the kettle. The heat enters the lower heat chamber until it reaches the rear of the kettle, then the draft draws the heat through the upper heat chamber to the front of the kettle and out the flue. This constant heat over the entire kettle prevents hot spots that cause flashing. Gives fast, efficient heating. The Littleford 84-HD Kettle is the fastest heating, most efficient kettle on the market today—Write for details.

The Littleford patented "Double Heat Circulation" and the "Screened Reservoir" makes the Littleford 84-HD Kettle heat faster and more efficient. The "Screened Reservoir" keeps the cold materials from the melted materials, also forces the newly added materials to the hot sides of the kettle, producing faster melting. The reservoir of melted material is always hot and ready to be drawn off. The 84-HD Kettle with Hand Spray Attachment gives speed to application—for skin patching, shoulder redressing, crack filling, etc.

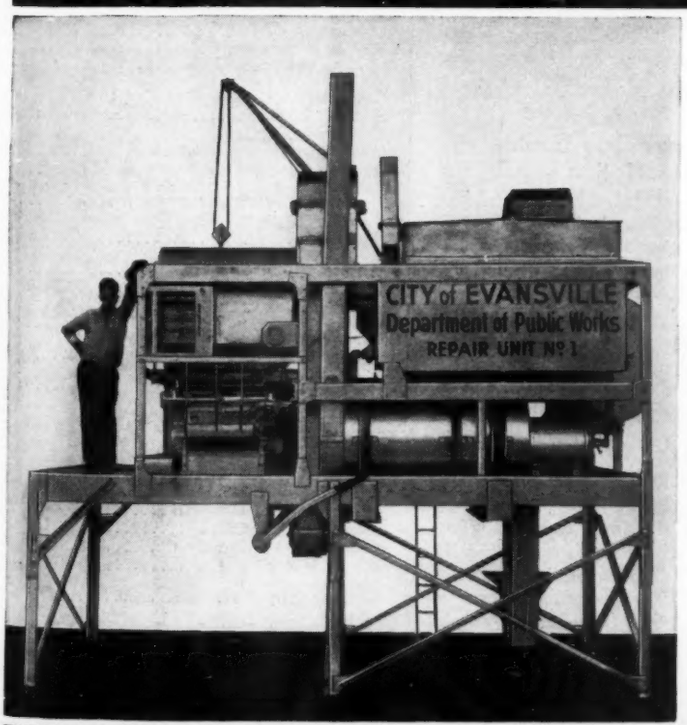




LB LITTLEFORD

LITTLEFORD BROS. . . CINCINNATI, OHIO

AUTOMATIC ASPHALT PATCH PLANT



H&B

- A COMPACT, EFFICIENT, ONE-UNIT ASPHALT REPAIR PLANT.
- FOR ACCURATE BATCH MIXING.
- STATIONARY OR PORTABLE TYPES.

MANUFACTURED BY

HETHERINGTON AND BERNER, INC.
ENGINEERS AND MANUFACTURERS
701-745 KENTUCKY AVENUE » » » INDIANAPOLIS, INDIANA

Cuts Hauling & Dumping Costs

The Brooks **LOAD LUGGER**

PATENTED & PATENTS PENDING

Don't overlook the cost-cutting possibilities of the Brooks Load-Lugger. It's the most practical, fool-proof, and greatest cost-cutting method known, for hauling and dumping any material where loading is done by hand. One truck with a "litter" of bodies . . . is the Load-Lugger way. Made in four capacities, shipped assembled, ready for installation on any truck chassis in a few hours.

ONE MAN OPERATED from driver's seat. No sheaves, cables, or "gadgets" to worry with. Buckets rest directly on chassis, no suspended load. Its speed and performance is almost unbelievable. For complete details and prices write the manufacturers. Demonstrations arranged in most sections.

BROOKS EQUIPMENT & MFG., CO.

47 DAVENPORT ROAD, KNOXVILLE, TENN.

MEETINGS

New England Water Works

The 57th annual meeting of the Society will be held at Hotel Statler, Boston, Mass., Sept. 13-16.

12th National Asphalt Conference

The 12th National Asphalt Conference will be held in Los Angeles, Calif., during the week of Feb. 20, 1939, under the auspices of the Asphalt Institute, with J. E. Pennybacker, Managing Director, General Chairman, and Daniel B. Miller, Managing Engineer of the Pacific Coast Division, co-chairman.

Four States Section AWWA

The annual meeting of the Four States Section of the AWWA will be held in Washington, D. C., October 6 and 7, with headquarters at the Raleigh Hotel. C. A. Hechmer, Deputy Engineer, Washington Suburban Sanitary District, Hyattsville, Md., is Secretary.

Montana National Bituminous Conference

The Montana Highway Department and the Western Petroleum Refiners Association, joint sponsors of the Montana National Bituminous Conference, have accepted the invitation of the State of Mississippi and the Mississippi Highway Department to hold the 1938 conference at Edgewater Park, Miss. At the meeting, which will be held Oct. 10 to 13, the subjects to be covered will include: Progress in research as related to construction and maintenance of bituminous surfaces, N. W. McLeod, chairman; Fundamentals of bituminous construction, T. E. Stanton, chairman; Construction of bituminous surfaces, V. B. Steinbaugh, chairman; and Maintenance of bituminous surfaces, A. B. Nuss, chairman.

American Public Health Association

The 67th Annual Meeting of the American Public Health Association will be held in Kansas City, Mo., October 25-28. More than 400 papers and reports will be presented and discussed in the four days the public health profession is in convention. The delegates are drawn from every state in the Union, from Canada, Cuba and Mexico and from every branch of public health practice. This makes necessary many individual meetings of the Association's ten sections—Health Officers, Laboratory, Vital Statistics, Public Health Engineering, Industrial Hygiene, Food and Nutrition, Child Hygiene, Public Health Education, Public Health Nursing and Epidemiology. A number of symposia will bring together three and four of these divisions on such subjects as The Phosphatase Test in the Control of Milk Pasteurization; The Use of Biological Products; Water and Sewage; Frozen Desserts; Typhoid Fever; Pertussis; Nutritional Problems; Industrial Hygiene.

Index to ADVERTISEMENTS

Activated Alum Corp. ..... Front Cover
Alvord, Burdick, & Howson 65
Armco Culvert Mfr. Assn 55
Atlas Mineral Products Co. 57
Austin-Western Road Mach. Co. 3

Black & Veatch 65
Brooks Equipment & Mfg. Co. 70
Browne, Floyd G. 65
Buffalo-Springfield Roller Co. 28
Burns & McDonnell Engr. Co. 65

Caird, James M. 65
Calcium Chloride Assn. 5
Cast Iron Pipe Research Assn. 2
C. H. & E. Mfg. Co. 27
Columbia Alkali Corp. 5
Cramer & Sons, Inc., Robert 65

Darling Valve & Mfg. Co. 8
De Witt Hotels 28
Dorr Company, The 45
Dow, A. W., Inc. 65
Dow Chemical Co. 5

Filtration Equipment Corp. 51
Ford Meter Box Co. 33
Friez & Son, Inc., Julien P. 36
Frink, Mfr., Carl H. 29
Fuller & McClintock 65

Goodyear Tire & Rubber Co. 21
Gorman-Rupp Co. 66
Greeley & Hansen 66
Green Co., Howard R. 65

Harrub Engineering Co. 65
Hetherington & Berner, Inc. 69
Hill Associates, Nicholas S. 65
Huber Mfg. Co. 66

Industrial Chemical Sales Div. 6
International Harvester Co. 23
International Salt Co. 75

Jaeger Machine Co. 27, 33

Littleford Bros. 69
Layne & Bowler, Inc. 25
Lock Joint Pipe Co. 35

McWane Cast Iron Pipe Co. 24
Metcalf & Eddy 65
Michigan Alkali Co. 5
Monsanto Chemical Co. 59
Morse Boulger Destructor Co. 63

National Paving Brick Assn. 29
Nichols Engineering & Research Assn. 4
Norton Company 53

Pacific Flush Tank Co. 47
Pirnie, Malcolm 65
Potter, Alexander 66
Proportioneers, Inc. 74

Quinn Wire & Iron Works 63

Robert & Co. 66
Roberts Filter Mfg Co. 36
Roots-Connersville Blower Corp. 61
Russell & Axon Cons. Engrs., Inc. 66

Salomon & Bro. L. A. 36
Simplex Valve & Meter Co. 59
Smith & Co., Gordon 27
Solvay Sales Corp. 5
South Bend Foundry Co. 61
Sterling Engine Co. 35

Trohn's Supplies, Inc. 33

U. S. Pipe & Foundry Co. 31

Wallace & Tiernan Co. ..... Back Cover
Weston, L. A. 61
Whitman & Howard 66
Wiedeman & Singleton 66
Wilson Engr. Co. 66

Readers' Service Department

CONTINUED FROM PAGE 72

These booklets are FREE to readers of PUBLIC WORKS.

Feeders, Chlorine and Chemical

387. For chlorinating small water supplies, swimming pools and other installations. Flow of water controls dosage of chlorine (or other chemicals) providing required dosages, which are immediately adjustable. Driving is started and stopped automatically. Send for newest literature. %Proportioneers%, 9 Codding St., Providence, R. I.

Filter Plant Controllers

388. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Flow Meters

389. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Gate Valves and Hydrants

390. An 84-page catalog gives full design data, information about and illustrations of the complete line of Darling Gate Valves and Hydrants. Write for one to Darling Valve and Mfg. Co., Williamsport, Pa.

391. Two new bulletins on M-H fire hydrants and fully bronze mounted gate valves are now ready. Contain full specifications and instructions for ordering, installing, repairing, lengthening and using. Write M. & H. Valve & Fitting Co., Anniston, Ala.

392. 28 page catalog contains illustrations and complete specifications of M-H standard and extra heavy iron body gate valves, horizontal swing check valves, flanged fittings and flanges, etc. Sent promptly on request by M. & H. Valve & Fittings Co., Anniston, Ala.

Indicators, Rate of Flow

400. This rate of flow indicator is a new, simple, compact, ruggedly constructed instrument which indicates flow with great accuracy in filtration and softening. Described and illustrated in new bulletin issued by The Permutit Company, 330 West 42nd St., New York, N. Y.

Manhole Covers and Inlets

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pipe, Cast Iron

406. Data on cast iron pipe for water works systems, in sizes from 1¼ to 84 inches, including information on useful life, flow data, dimensions, etc., Thos. F. Wolfe, Cast Iron Pipe Research Ass'n, 1013 Peoples Gas Bldg., Chicago, Ill.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe, Large Cast Iron

408. Handy cast iron pipe and fittings catalog contains A.W.W.A. and A.G.I. standard specifications for a wide variety of cast iron pipe specialties, both bell and spigot and flanged; also dimensions Lynchburg Foundry Co., Lynchburg, Va.

409. Information on concrete pipe for sanitary or storm sewers which can be made anywhere by manufacturer using local labor and materials. Write Concrete Pipe Machinery Co., Sioux City, Iowa.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

416. Stop Root rings are used with clay or concrete pipe, without special tools, to make perfect joints that prevent roots entering sewer. Joints are made in usual way. A-B-C Mfg. Co., 227 So. 4th St., Quincy, Ill.

Taste and Odor Control

417. How, when, and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps, fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for these three descriptive booklets. Layne & Bowler, Inc., Dept. W, General Office Memphis, Tenn.

Pumping Engines

424. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Root-Proofing

425. Free sample of "Stop Root Ring" for root-proofing clay or concrete pipe without tools, and complete descriptive matter will be sent on request to A-B-C Mfg. Co., 227 So. 4th St., Quincy, Ill.

Run-off and Stream-Flow

426. Excellent booklet describes and illustrates the latest types of instruments for measuring run-off, both from small areas for storm sewer design, and from large areas for determining water shed yield. Sent promptly by Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

428. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago, Ill.

Setting and Testing Equipment for Water Meters

430. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co., Wabash, Ind.

Rainfall Measurement

432. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Bulletin RG and Instruction Booklet. Julien P. Friez & Sons, Baltimore, Md.

Screens

435. Water Screen Book No. 1252, describes traveling water intake screens and gives complete technical information about them. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill.

Sewage Filters, Magnetite

436. Well illustrated booklet describes the magnetite filter, and tells how it is used in the treatment of Sewage. Copy on request from Filtration Equipment Corp., 10 East 40th St., New York, N. Y.

Small Septic Tanks

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip, Inc., 700 Brighton Ave., Syracuse, N. Y.

Sludge Incineration

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Suggestions for plant inspection, 45 pp., ill. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 202P East 44th St., N. Y.

Swimming Pool Equipment

444. A new booklet "Essential Factors in the Design and Layout of Swimming Pool Systems," with data on filtration equipment, fittings, solution feeders, accessories, etc., is available from Everson Manufacturing Co., 213 West Huron St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

446. 40-page Manual on swimming pools. Includes swimming pool layouts, specifications, etc., and details concerning Permutit Swimming Pool Equipment. Write The Permutit Co., Dept. G-4, 330 West 42 St., New York, N. Y.

Treatment

450. Standard Sewage Siphons for small disposal plants and PFT Rotary Distributors are new catalogs recently issued by Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill. The latter catalog contains typical plans and many illustrations of actual installations.

453. New booklet on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures and drawings of installations, sanitary engineering data and design details. Link-Belt Company, 307 North Michigan Ave., Chicago, Ill.

454. Full information regarding their newest equipment for sewage treatment and water purification will be sent on request by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Water & Sewage Treatment Chemicals

500. Aluminum sulphate and ferric chloride for sewage coagulation, and these chemicals and ammonia, copper sulphate and others for water treatment. Information on uses and methods sent on request to General Chemical Co., 40 Rector St., New York, N. Y.

501. "Ferrisul for water and sewage treatment." What it is; what it will do for you and how to use it—a handy booklet issued by Merrimac Chemical Co., Everett Station, Boston, Mass.

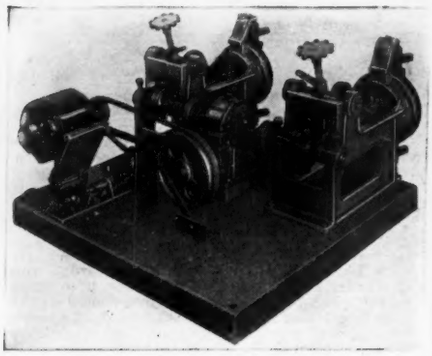
Valve Box Tops

475. "Cut the Cost, but Not the Pavement," is the theme of a new bulletin on Rite-Hite Valve Box Tops. Gives directions for forming new tops on valve boxes, quickly and inexpensively without digging up the old box. Just issued by Trohn's Supplies, Inc., 205 Hoyt Ave., Mamaroneck, N. Y.

Water Works Operating Practices

490. "What Is New In Coagulation" is an excellent, new review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Activated Alum Corp., Curtis Bay, Baltimore, Md.

%PROPORTIONEERS%



Duplex Adjust-O-Feeder with belt shifter for feeding two chemicals in proportion to flow.

AMM-O-FEEDERS

Automatic Ammoniators, feeding aqua ammonia in proportion to flow, have two major advantages:

1. **The cost of ammonia in liquid form is only about one-half the cost of gaseous ammonia.**

2. **First cost of feeding equipment is much lower. Upkeep cost negligible.**

There is no limit to the size of plant which can use Amm-O-Feeders more economically.

Whatever chemical you are feeding: alum, ammonia, activated carbon, lime, hypochlorite, soda ash, ferric chloride, ferric sulphate—it will pay you to get recommendations from %Proportioneers%.

%PROPORTIONEERS% LED THE WAY TO LOW COST CHEMICAL FEEDING

% PROPORTIONEERS % Inc.

Associated with Builders Iron Foundry

96 CODDING STREET PROVIDENCE, R.I.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

Water Analysis:

This is a 92-page text on methods of analyzing water for municipal and industrial use. It covers mineral analyses, stationary boiler water analyses, municipal water supplies, railroad water supplies, swimming pool water, polluted waters, reagents, indicators and standard solutions, and useful information. Bacteriological examination and sanitary analysis are omitted. The methods presented are those found useful for rapid work without undue sacrifice in accuracy; most of them are based on long experience, while others embody recent developments. A very good text. Ask for Bulletin 11 (no charge), Solvay Sales Corp., 40 Rector St., N. Y.

Retaining Walls:

This is a 16-page technical bulletin on cellular type retaining walls. Sizes, details and suggested plans are shown. Uses illustrated include slope stabilization, wing walls, restricted right of way, erosion prevention and bank protection. There is a lot of good information on retaining walls. Sent on request. Armco Culvert Mfrs. Ass'n, Middletown, Ohio.

Structural Aluminum:

Fundamental information regarding the strength of structural members fabricated from aluminum alloys is covered in this 200-page text. It is a very good design manual. Aluminum Co., of America, Pittsburgh, Pa. $1.25.

Health Work Appraisal:

The American Public Health Ass'n, 50 West 50th St., New York, has issued an "Appraisal Form for Local Health Work," a 200-page document which is meant primarily as a measuring rod for community health services. There are three major sections: A survey schedule for studying a community's health facilities; a schedule for appraising the local health activities; and a list of significant health indices. No price is given us in connection with this.

Tunnel Lining:

"Armco Structural Steel Plate Linings for Tunnels, Shafts and Conduits" is a 16-page bulletin which describes such installations and presents helpful design information. Field photographs show typical jobs. American Rolling Mill Co., Middletown, Ohio.

Sludge Dewatering:

Oliver Sewage Sludge Dewaterers are described briefly and a list of installations given in a 4-page booklet. Ask for Bulletin 240, Oliver United Filters, Inc., 33 West 42nd St., N. Y.

A Mechanical Imhoff Tank:

The Dorr "Clarigester" is a combination of a mechanical clarifier and a mechanical digester in a single 2-story tank. It works like an Imhoff (better, according to the manufacturer), the upper chamber providing the settling space, and the downstairs the digestion apartment. It is built as a circular unit. Where it costs real money to get down deep, this will help, because required depths are much less than for the standard Imhoff. Ask for Bulletin 6681C, Dorr Co., Inc., 570 Lexington Ave., N. Y.

Measuring Taste and Odor:

The method, the apparatus and the procedure for measuring tastes and odors in raw and tap water are shown on a 16- x 10-inch chart. This is the simplest, clearest and most striking layout we have seen. If you have or may have tastes and odors, this will ease your mind and show you how. Sent on request to Industrial Chemical Sales, 230 Park Ave., N. Y.

Magnetite Filter:

A 12-page booklet which tells what has been accomplished in solids removal in sedimentation, chemical precipitation, activated sludge, trickling filter and Imhoff plants, with curves showing removal. Description of the magnetite filter, with drawings; design features; data on rates and on costs, both installation and operating. Filtration Equipment Corp., 10 East 40th St., New York.

Rats:

Supplement to Public Health Reports, No. 131. The rat and ratproof construction of buildings. With specifications, drawings, and photographs and a model ratproofing ordinance. By B. E. Holsendorf. Drawings by P. W. Clark. 1937. 68 pages; 31 plates. U. S. Public Health Service, Washington D. C.

Concrete Vibrators:

Quite a lot of information on vibrators and their use in concrete construction work. On mimeographed sheets. Most of the information, of course, is about Munsell vibrators, but other good dope. Munsell Concrete Vibrators, Teaneck, N. J.

Lubricating Diesel Tractors:

The usual complete treatment of this subject is given in the June issue of "Lubrication," published by the Texas Co. Also a chart for lubricating Caterpillar, Cletrac and International diesel tractors. We believe a copy will be sent on request to Texas Co., 135 East 42nd St., New York.